Basinwide Management of Water in the

Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins

Draft Report

This is a draft of the report that will summarize the basinwide management study up to its scheduled completion on September 30, 1996. At that point, however, several economic studies that were to have been used in the basinwide analysis will not have been completed, and the formulation and evaluation of alternatives will have just begun in earnest. As this draft is being printed, the partners are discussing an extension of the Comprehensive Study. If that occurs, this report may be updated to reflect economic findings and additional work on alternative water management strategies.

August 1996

Table 1. Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint Comprehensive River Basins Study Reports

Agriculture	ACT/ACF River Basins Comprehensive Study; Agricultural Water Demand; Appendix B; Basinwide Management Shared Vision Data", March 1996
Groundwater	(1) Georgia: Upper Chattahoochee River; Piedmont Hydrogeologic Province; Chattahoochee and Flint Rivers; metro Atlanta portion of the Piedmont Hydrogeologic Province. (2) Georgia: Chattahoochee and Flint Rivers; Piedmont Hydrogeologic Province; combined with Alabama: Chattahoochee River; Piedmont Hydrogeologic Province. (3) Georgia: Chattahoochee and Flint Rivers; Cretaceous-Tertiary Belt of Coastal Plain Hydrogeologic Province; combined with Alabama: Chattahoochee River; Cretaceous-Tertiary Belt of Coastal Plain Hydrogeologic Province. (4) Alabama, Florida and Georgia: Lower ACF Basin; Floridan Aquifer of Coastal Plain Hydrogeologic Province. This subarea also includes shallow aquifers adjacent to the Apalachicola River in Florida. (5) Georgia: Tallapoosa River; Piedmont Hydrogeologic Province; combined with Alabama: Tallapoosa River; Piedmont and Coastal Plain Hydrogeologic Provinces. (6) Georgia: Coosa River; Piedmont and Valley and Ridge Hydrogeologic Provinces; combined with Alabama: Coosa River; Valley and Ridge Hydrogeologic Province. (7) Alabama: Cahaba River; Valley and Ridge, and Coastal Plain Hydrogeologic Provinces. (8) Alabama: ACT River Basin; Coastal Plain Hydrogeologic Province; metro Montgomery portion of the Coastal Plain Hydrogeologic Province.
Municipal and Industrial Water Use	Davis, William Y.; Michael T. Beezhold; Eva M. Opitz; Benedykt Dziegielewski. <u>ACT-ACF Comprehensive Study; Municipal and Industrial Water Use Forecasts. Volume I: Technical Report</u>. Planning and Management Consultants, Ltd.

Copies of these reports may be obtained from ....
Electronic versions of these reports can be downloaded from

Alabama-Coosa-Tallapoosa
and
Apalachicola-Chattahoochee-Flint
River Basin Comprehensive Study

DRAFT REPORT
ACT-ACF BASINWIDE STUDY

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Submitted to:

Alabama Department of Economic and Community Affairs
Northwest Florida Water Management District
Georgia Department of Natural Resources
U.S. Army Corps of Engineers Mobile District

August 1996

UNITS OF MEASUREMENT

The participants in the Basinwide Study melded many differences to develop a shared vision, including different units of measurement for the same phenomenon. Two of the most commonly used measurements are the rate at which water flows and the volume it occupies.

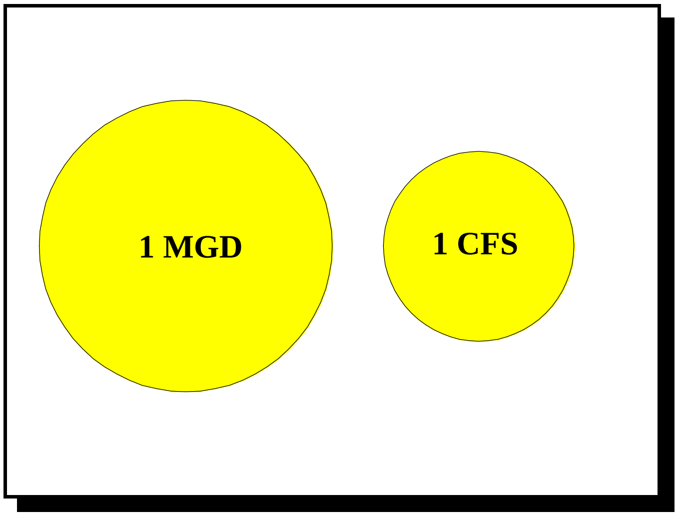

Figure 1. An MGD Is About 1½ CFS.

Rates of Flow. When discussing river flows, the standard unit of measure is "cubic feet per second" (cfs). When discussing the rate at which cities use water, the term "millions of gallons per day" (MGD) is normally used. Both terms are used in this report and in the basinwide computer models. Water flowing at a rate of 1 MGD flows at the rate of 1.547 cfs. In the western U.S. and in agriculture, the term "acre-feet per year" is also used. A flow of 724 acre-feet per year is a flow of 1 cfs. A flow of 1,120 acre-feet per year is a flow of 1 MGD.

Volumes . The volume of water held in a reservoir is most often measured in acre-feet, the volume of water that would cover one acre at the depth of one foot. A million gallons is about 3 acre-feet. In the computer models developed for the basinwide study, the amount of water held in a reservoir and the amount of water released from or entering a reservoir in one month was measured in "cfs-days", the volume that would be filled by a flow of 1 cubic feet per second running for 24 hours. 1 cfs-day is about 1.98 acre-feet or about 646,000 gallons.

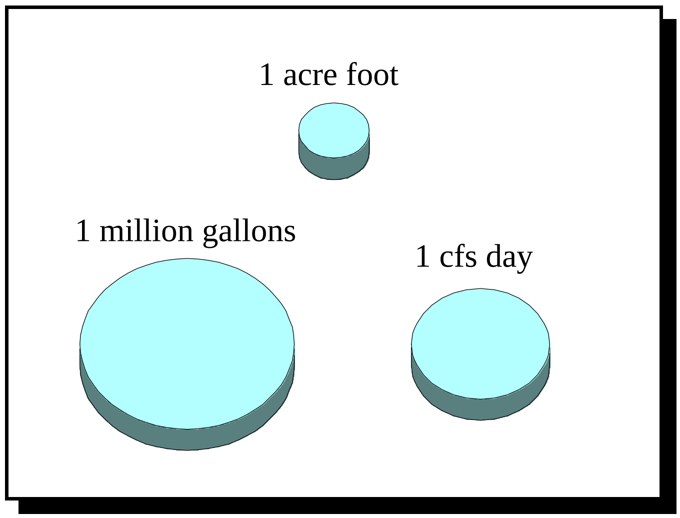

Figure 2. The cfs-day is about 2 acre feet

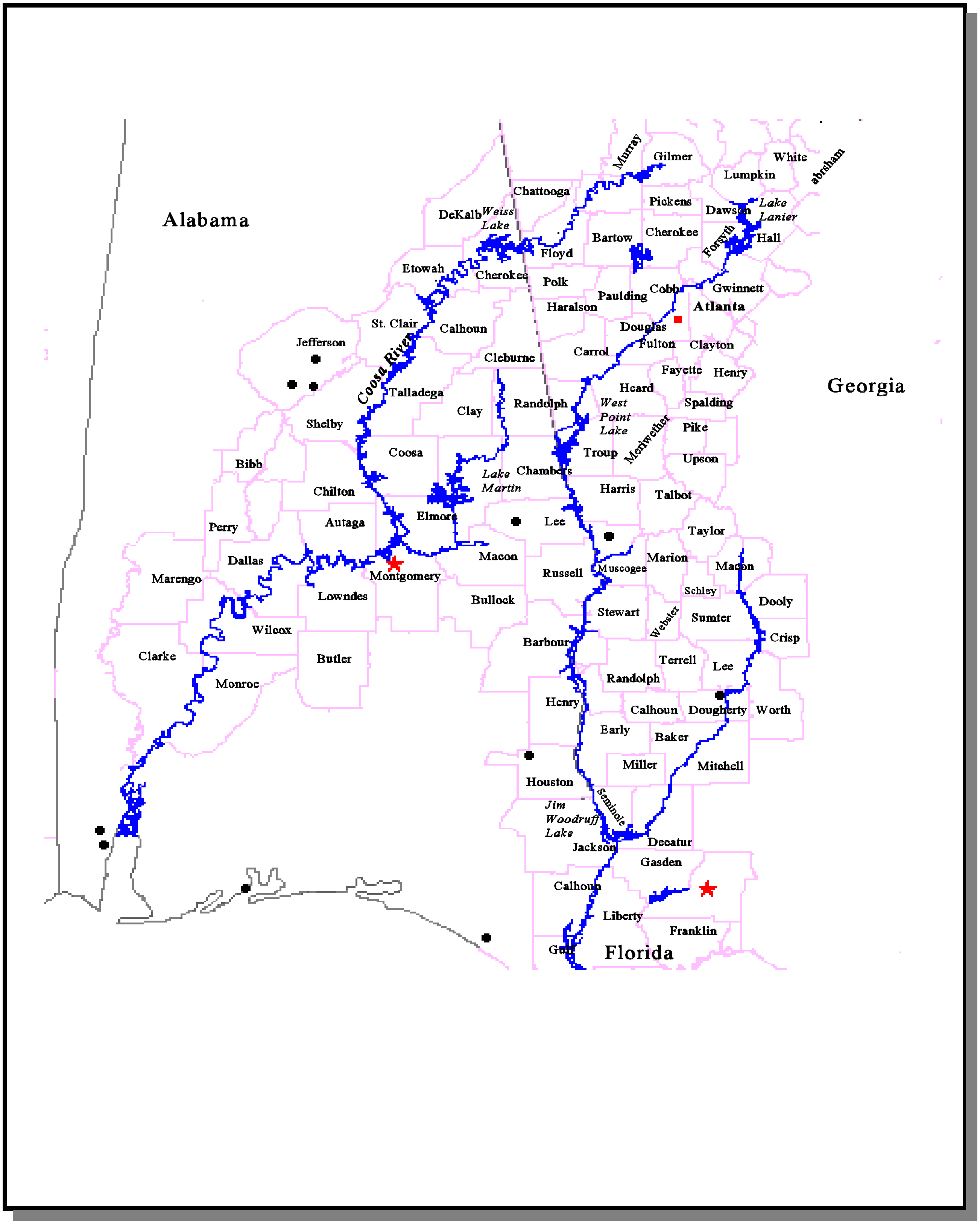

Figure 3. The ACT and ACF Basins

EXECUTIVE SUMMARY

This is a draft report on the results of the Basinwide Management element of the Comprehensive Study. It is the companion to the ACT-ACF Shared Vision Model, and uses results from the revised draft version of which was posted on July 26, 1996[1]. The model consists of a family of Excel® workbooks linked to STELLA II® simulation models of the ACT and ACF. The model is a monthly timestep simulation model designed to serve the strategic planning goals of the Comprehensive Study. The two fundamental questions the basinwide study addressed were: "will there be enough water?" and "is there a better way to manage water?".

The analysis in this report is based on water supply and demand data prepared by other study elements that have been approved or are being approval by the Technical Coordinating Committee (TCG). The ACT-ACF Shared Vision Model is now able to provide detailed answers to the first fundamental question about the long term balance of supply and demand. The report also discusses economic and environmental impact studies, and some navigation alternatives, that have not been reviewed or approved by the TCG. This information is included in pre-draft form to show how it could be used in an evaluation, but readers should not assume that it is acceptable to the TCG. It has not been used in the sample model runs. Because so much of the economic and environmental data will not be approved or even available in draft form by September 30, 1996, and because so many alternatives require the Corps of Engineers to determine changes in economic and environmental benefits, more work will be required after September 30th before the model can be used to select or even fully evaluate alternatives.

Development of the models and this report proceeded continuously through July in order to include as much as possible in the form of desired modeling changes or late arriving data from other studies. Model development is essentially complete now. The partners will submit comments on the draft shared vision model in July, 1996. The draft models will be demonstrated and tested in August. The partners and the University of Washington have already run hundred's of alternatives with earlier versions of this model; formulating and evaluating alternatives with the draft models will be the primary test of whether the battery of control options in the model is internally consistent and reliable.

Because the model and some of the data are in draft form, no findings or conclusions were drawn from initial model runs. Instead, hypotheses that can be tested with the model during the review period were made for the major study issues:

Atlanta Water Supply. HYPOTHESIS: *Under most alternatives, Atlanta's water supply needs are satisfied completely. The more stringent M&I conservation measures studied have little effect on M&I reliability or the impact of M&I on other uses. This is because M&I consumptive use is relatively small compared to streamflow rates, and because some of the most effective conservation measures are already legislated. At this point, however, perfect reliability of water supply induces small reductions in the reliability of recreation, navigation, and/or power.*

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[1] Models and documentation are posted on a University of Washington Home Page. Its address is http://atlas.ce.washington.edu/~actacf.

Water Related Recreation. HYPOTHESIS: *Recreation on ACT lakes is supported with very high reliability under a broad range of alternatives and demands. Recreation on ACF lakes will be much less reliable. Lanier, in particular, is vulnerable since its ratio of storage to inflow is so large. Under 2050 consumptive demands , Lake Lanier will be 5 feet or more below normal about half the time, and about 13 feet below normal one fourth the time.*

Chattahoochee River Water Quality. **HYPOTHESIS:** *Many alternatives will allow reliably meeting a minimum flow of 1,650 cfs (rather than the current 1,150 cfs) at Columbus, but there may be a small price to pay in terms of Lanier recreation*.

South Georgia Irrigation. **HYPOTHESES:** *Flows into Apalachicola Bay and navigation channel reliability will be noticeably affected by increased irrigation in this area. Moreover, uncertainty about future agricultural water use and the effect of pumping on surface flows translates into sizable differences in flows at Blountstown. The differences in the flows caused by these uncertainties is about the same as the change in flows that would occur if M&I demands in the basin were doubled.*

Navigation Reliability. HYPOTHESIS: *It will be difficult to create 100% reliability for even 7½ foot depths in the Apalachicola River, and constant 9 foot depths seems impossible without new reservoirs or locks. The ACT is more promising, with high reliability even under the current operating rules.*

Interbasin Transfers. *During portions of the year, under dry conditions, transfers from the Coosa River Basin to supplement M&I water supply from the Upper Chattahoochee River Basin to help keep Lake Lanier relatively full, but still provide the 750 cfs minimum flow requirement at Peachtree Creek. Tallapoosa River basin transfers can help supplement the Chattahoochee River as a water supply source for Georgia.*

Alabama's Potential to Grow and Use Water in the Future. HYPOTHESIS: *The proposed West Georgia Reservoir could increase Georgia Piedmont M&I reliability and satisfy minimum flows more reliably at the Georgia-Alabama state line.*

Apalachicola River and Bay. HYPOTHESIS: *The range of uncertainty in the effects of groundwater pumping on surface flows, and long term future agricultural demands translates into a nearly 1000 cfs difference in average June inflows into the Bay.*

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ACKNOWLEDGMENTS

The basinwide element was a part of a much larger study, which in turn is part of a history of competition for water in these basins. I cannot acknowledge all those whose decisions made it possible to negotiate, rather than litigate those differences, but I would like to thank the Executive Coordinating Committee members, Richard J. Laird, Joe Tanner, Colonel William Vogel, and Virginia Wetherell, who kept the commitment of the Corps and the states to this process even when it was difficult to do so. I would also like to thank the Technical Coordination Group, Doug Barr, Keith Graham, Harold Reheis, and Walter Stevenson, whose decision it was to use shared vision planning for this study.

The work in the basinwide element was charted and supported by the members of the Basinwide Management Working Group. In no other application of the shared vision process has there been as great an involvement on the part of the principal decision makers in the development of shared vision models. In a series of 11 workshops, monthly teleconference calls, and nearly continuous use of e-mail and websites, this group made sure the models reflected the true operation of the system and represented stakeholder concerns. The Working Group membership has expanded and contracted over the years; if a core group were to be identified, it would consist of Steve Leitman, Ruben Arteaga, and Janet Starnes (Florida); Nolton Johnson and Owen McKeon (Georgia), Bob Grasser and Tom Littlepage (Alabama), and Eric Nelson and Memphis Vaughan for the Mobile District.

The concept of shared vision modeling is the brainchild of Professor Richard N. Palmer of the University of Washington. Dr. Palmer convinced the Corps of Engineers to use his approach during the National Drought Study (1990-93) and its success there has led to its more widespread use. Its potential for assisting water negotiations is discussed in more detail on page 8, but it must be said that this process would not have been successful in this instance if they had not been developed under the personal supervision of Dr. Palmer. His imagination is matched by his dedication, his unrelenting focus on important results, and his ability to attract truly bright and multi-talented graduate students. His honesty and competence undoubtedly helped give the partners confidence in the shared vision concept.

Our formal relationship with the partners extended from June 1994 to October 1996, but we were involved informally since 1992. During those years Captain Keith Rivenbark, Lise Johannesen, David Meyer, William Rowden, Alan Hamlet, Joe Trungale, Dennis Mekkers, and Sumaya Haddadin earned their masters degrees on this project. I am grateful to all, but especially Captain Rivenbark who showed that a working STELLA model of the basin could be built quickly and inexpensively, and to Joe and Alan, who proved that we could also build a very complex and extraordinarily powerful planning model that was at the same time relatively easy to use.

Jay Lund and William Whipple, Jr. helped write an earlier “mock” version of this report, some of which was carried over to this draft. Trey Glenn and Ed Burkett offered expert advice on a variety of subjects. Ed was especially helpful in the early development of the models, and lately, in policy matters. Trey’s advice and enthusiastic use of the modeling approach was invaluable in developing the “Water Balance” models. I know that many people’s confidence in our efforts grew because Trey worked with us. Charles Stover’s strong straightforward statements about the usefulness of the Shared Vision Model came at a critical point in the study, and I am grateful that he spoke in support of our models.

Basinwide combines all the demand studies, and I am grateful to all the contractors who helped us translate their results, in particular, Jerry Ziewitz (U.S. Fish and Wildlife Service), Gary Jones (Natural Resources Conservation Service), Bill Davis and Eva Opitz (Planning and Management Consultants, Ltd.), Kamau Sadicki, Ed Woodruff, and Dick Mittlestadt (Corps of Engineers, North Pacific Division), and Mark Dortch, Scott Jackson, and Dan Allen (Corps of Engineers, Waterways Experiment Station), David Grier (IWR), as well as all the staff at the Mobile District.

At IWR, Lisa Theriault helped with research, graphic design, and editing. Gene Stakhiv (Chief of my division) and Kyle Schilling (the director of IWR) decided in 1993 that I could commit a great portion of my time to a non-IWR project with a significant risk of failure. Their decision is consistent with the mission IWR has, which is to solve difficult problems by applying new ideas in practical settings.

William J. Werick
Principal Author

I. INTRODUCTION

A. Background and Scope

In January, 1992, the governors of Alabama, Florida, and Georgia and the Assistant Secretary of the Army for Civil Works signed a Memorandum of Agreement (MOA) to conduct a comprehensive study of the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins. The Comprehensive Study addresses issues raised in a 1990 Alabama lawsuit against the Corps, and begins the process of basinwide management and planning in the ACT and ACF basins. By the end of the Comprehensive Study, the partners hoped to report on:

> *" . . . a conceptual plan for water resource management of all water resources, including management of federal and non-federal impoundments and reservoirs, in the ACF Basin and the ACT Basin; an assessment of the existing and future water resource needs, including the needs of human, economic, natural, and other systems, of the states within the ACF Basin (Alabama, Florida, and Georgia) and the ACT Basin (Alabama and Georgia) and the extent of water resources available within each basin to service such needs; and an appropriate mechanism or mechanisms to implement the findings or recommendations of the Comprehensive Study."* (MOA, 1992)

The partners undertook studies in each of the major goal areas: water supply and demand; basinwide management; and coordination mechanisms. The objectives of the Basinwide Management work were to:

assemble and compare the water resource needs and water availability in the ACT and ACF River basins

define problems and opportunities, planning objectives, decision criteria, performance measures, effects and constraints;

identify procedures to screen and prioritize alternative means of meeting the water needs through the year 2050.

build and use shared vision models to support the comparison and evaluation of alternatives.

This is a draft of the report that will summarize the basinwide management study up to September 30, 1996, the scheduled completion date for the study. At that point, however, several economic studies that were to have been used in the basinwide analysis will not have been completed, and the formulation and evaluation of alternatives will have just begun in earnest. As this draft is being printed, the partners are discussing an extension of the Comprehensive Study. If that occurs, this report may be updated to reflect additional economic findings and additional work on alternative water management strategies

B. The Geographic Area of the Study

Alabama-Coosa-Tallapoosa River System (ACT)

The ACT basin spans significantly only the states of Alabama and Georgia (Tennessee withdraws about 0.1% of the total ACT withdrawals) with a diverse mix of water resource system uses. Rivers on the ACT system are regulated by a large number of dams, most of which are run by the Corps of Engineers and the Alabama Power Company. These numerous but relatively small reservoirs are typically operated to maintain a near-constant month to month elevations for maintaining navigation, recreation, and hydropower potential.

The study partners agreed to exclude Mobile Bay from the Comprehensive Study. The Alabama River flows into the Mobile Bay, but is joined just above the Bay by the Tombigbee River, which drains an area extending well into Mississippi approximately equal in extent to that of the ACT. Therefore, if comprehensive plans were to be made to protect the Mobile Bay estuary system from effects of depletive water use upstream (or effects of pollution), this study would have had to include the Tombigbee as well, an unacceptable expansion of the work.

Apalachicola-Chattahoochee-Flint River System (ACF)

The ACF basin spans portions of three states: Alabama, Florida, and Georgia, as shown in ?, page ?. This river system is used extensively for recreation, water supply, power production, flood control, navigation, and environmental fish and wildlife purposes. The four major storage reservoirs available to affect flows on this system are described in **Table 3**. Lake Lanier has the largest storage capacity, but it also has the lowest ratio of inflow to storage, indicating that it is likely to be slower to recover from drought-induced drawdowns than other reservoirs on the system. Significant seasonal flood control storage is maintained on both Buford and West Point reservoirs. The lower reservoirs, Walter F. George (Lake Eufala) and Jim Woodruff (Seminole), are generally operated to maintain a constant water level for navigation, recreation, and power generation. All major reservoirs on the ACF are federally owned and operated by the U.S. Army Corps of Engineers.

The Flint contributes more than half the mean annual flow of the total ACF system, and is relatively unregulated, with only a few very small water supply, recreation, and hydropower dams upstream of Jim Woodruff at the confluence with the Chattahoochee.

The Southeast Power Administration (SEPA) sells power through the joint operation of 10 hydropower plants in the region, including four on the Savannah River. Although changes in hydropower production in the ACT-ACF can be buffered with operation of the Savannah plants, the study partners agreed to include the contributions of those plants as a constant, rather than expand the study to include the Savannah River Basin.

Table 2. Corps Reservoirs on the ACT System

Lake Name	Dam Name	Mean Annual Inflow[1]	Drainage Area (sq. mi.)	Total Storage Volume[1]	Months of Average Flow Needed to Fill Reservoir
Carter's Lake	Carter's Dam	0.8	376	0.47	7.0
Allatoona Lake	Allatoona Dam	1.3	1,100	0.67	6.1
R.E.(Bob) Woodruff Lake	Robert F. Henry Lock and Dam	17.9	16,300	0.23	0.15
William (Bill) Dannelly Reservoir	Miller's Ferry Lock and Dam	22.5	20,700	0.33	0.18
Claiborne Lake	Claiborne Lock and Dam	23.6	21,520	0.10	0.05

1 - in millions of acre feet

Table 3. Corps Reservoirs on the ACF System

Lake Name	Dam Name	Mean Annual Inflow[1]	Drainage Area (sq. mi.)	Total Storage Volume[1]	Months of Average Flow Needed to Fill Reservoir
Lake Sydney Lanier	Buford Dam	1.5	1,040	2.55	20.4
West Point Lake	West Point Dam	3.7	3,380	0.71	2.3
W.F. George Lake; Lake Eufala	W.F. George Lock and Dam	7.4	7,364	1.03	1.7
Lake Seminole	Jim Woodruff Lock and Dam	15.9	17,150	0.37	0.3

1 - in millions of acre feet

C. Planning Period.

These analyses are meant to help develop strategies for managing water over the next half century. Water demands were forecast for the years 1995, 2000, 2010, 2020, and 2050. Measured and estimated river flows from January 1939 to December 1993, adjusted to remove the effects of water use and reservoir regulation, were used in the analyses. These historic flows included droughts. However, care must be taken in interpreting the results from this study for drought periods; the Comprehensive Study was not designed to be a drought response study, and more information would need to be developed before a true picture of how the basins would fare during future droughts would emerge. A discussion of the elements of a typical drought preparedness plan can be found on page 79.

D. Major Study Issues

Atlanta Water Supply. The Atlanta Regional Commission pursued multiple new water supply sources since the mid 1970's. The Atlanta metro area is one of the fastest growing areas in the country. Because it is located in the upper part of both the ACT and ACF basins, natural streamflows are too small to supply Atlanta during droughts, and there is very little groundwater. Alabama's lawsuit was in response to Corps of Engineers recommendations to reallocate space in Corps reservoirs to meet Atlanta metro water supply needs.

Water Related Recreation. Although not originally built for recreation, the reservoirs in these basins have become increasingly popular for boating and fishing, and development around the lakes has boomed. Lake Lanier in particular is one of the most visited sites in the country. When reservoirs are drawn down for water supply, hydropower, navigation or instream flow requirements, mudbanks are exposed and access is more difficult. The Corps tries to keep the lakes high when it can do so without hurting other purposes, but there is no storage allocated to recreation, and therefore, no assurance that the lakes will not be drawn down to meet other needs during droughts. Lanier is particularly sensitive because once drawn down, it takes longer than other reservoirs in these basins to refill (see **Table 3**).

Chattahoochee River Water Quality. Water quality problems stem primarily from treated wastewater discharges, discharges of untreated sewage into caused occasionally by overflows of combined storm and sanitary sewer systems, and non-point source pollution. Improvements in wastewater treatment facilities and construction of new separate sanitary and storm water systems will help counter the effects of higher rates of M & I wastewater returns and continuing non-point source runoff in the future, but the balance among these future trends has not been modeled in the Comprehensive Study. The current instream flow requirement for the Chattahoochee River at Peachtree Creek is a minimum of 750 cfs. Water quality modeling studies currently underway for this section of the river are not likely to dictate a reduction in the minimum flow below this level in the future. Similarly, the current instream flow requirement at Columbus is a minimum of 1,150 cfs, though there have been discussions of an alternative flow target of 1,650 cfs.

South Georgia Irrigation. Water pumped by South Georgian farmers reduces surface water flows into the Flint River, Lake Seminole, and Apalachicola Bay. This is a large, and increasing use of water. During the summer, South Georgia farmers pump more water than is withdrawn for Atlanta, and they are expected to use considerably more in the future.

Navigation Reliability. Navigation was one of the originally authorized purposes, but nine foot depths have never been available on a year round basis. The flows necessary to produce a nine foot depth have increased, and the amount of water available is less than supposed during reservoir design. Commercial navigation of both the ACF and ACT channels dropped considerably after the 1980's, when droughts led to reduced depths too often. As more water is used for cities and farms, the commitment to navigation could deteriorate more.

Interbasin Transfers. Atlanta withdraws some water from the ACT-ACF and returns the treated wastewater to a third basin to the east. This means that about 50 MGD of water that would otherwise have passed through Alabama or Florida on the way to the Gulf of Mexico goes into the Atlantic Ocean.

Alabama's Potential to Grow and Use Water in the Future. Alabama is concerned Atlanta will take the water Alabama needs for growth in the future.

Apalachicola River and Bay. Florida has fought to preserve the environmental value of the riparian corridor of the Apalachicola River by purchase and set aside of lands. The Bay is healthy now, but Floridians are concerned that there is no basinwide management that considers the cumulative effects of new supplies and transfers. Changes in the amount and quality of water coming from upstream can change the level of salinity and the populations and mix of species in the Bay.

II. PLANNING METHODS APPROACH

A. General

The partners elected not to use traditional Corps planning procedures and decision-making processes, as defined in Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, 1983 (P&G). Because the P&G is designed to be used in assessing the advisability of federal investments in water resources projects, it places a high priority on national economic benefits. In addition, in most Corps planning studies, Corps districts conduct the study and non-Corps partners review the results. Instead, the partners agreed to use the "shared vision planning" method developed during the recent National Study of Water Management During Drought, 1990-1994 (IWR Report 94-NDS-8). This method shares developmental roots with the P&G, but is not limited to analyzing federal investment decisions. It also is more amenable to non-structural solutions and includes methods of updating plans in an adaptive management setting. Most notably, though, it uses simulation models of the system under study that are built collaboratively by experts from participating agencies and stakeholders.

B. How the Basinwide Management Study Fits Into the Overall Process

The basinwide analysis integrated the water use and supply studies to answer two questions from a long term planning perspective:

"*Will there be enough water?*" and

"*Is there a better way to manage water in the basins?*"

The ACT-ACF study partners conducted studies to determine future water needs in each of several water use categories: the environment, municipal and industrial water supply, navigation, recreation, electrical power, and agriculture. The partners took inventories of current water use and the physical facilities associated with those uses, and conducted forecasts of population and employment in the basins. The inventory and population and employment studies provide data for some of the demand studies. Separate studies were conducted concerning the availability of surface water, the availability of groundwater, and water quality. Simply put, the basinwide analysis integrated this work to answer two questions: "*Will there be enough water?*" and "*Is there a better way to manage water in the basins?*"

C. Shared Vision Model

The most obvious difference between this basinwide effort and traditional planning efforts is the development of a "Shared Vision Model". Shared vision models are computer simulation models of water systems built, reviewed, and tested collaboratively with stakeholders. Building such a model collectively increases everyone's understanding of the entire system, and focuses

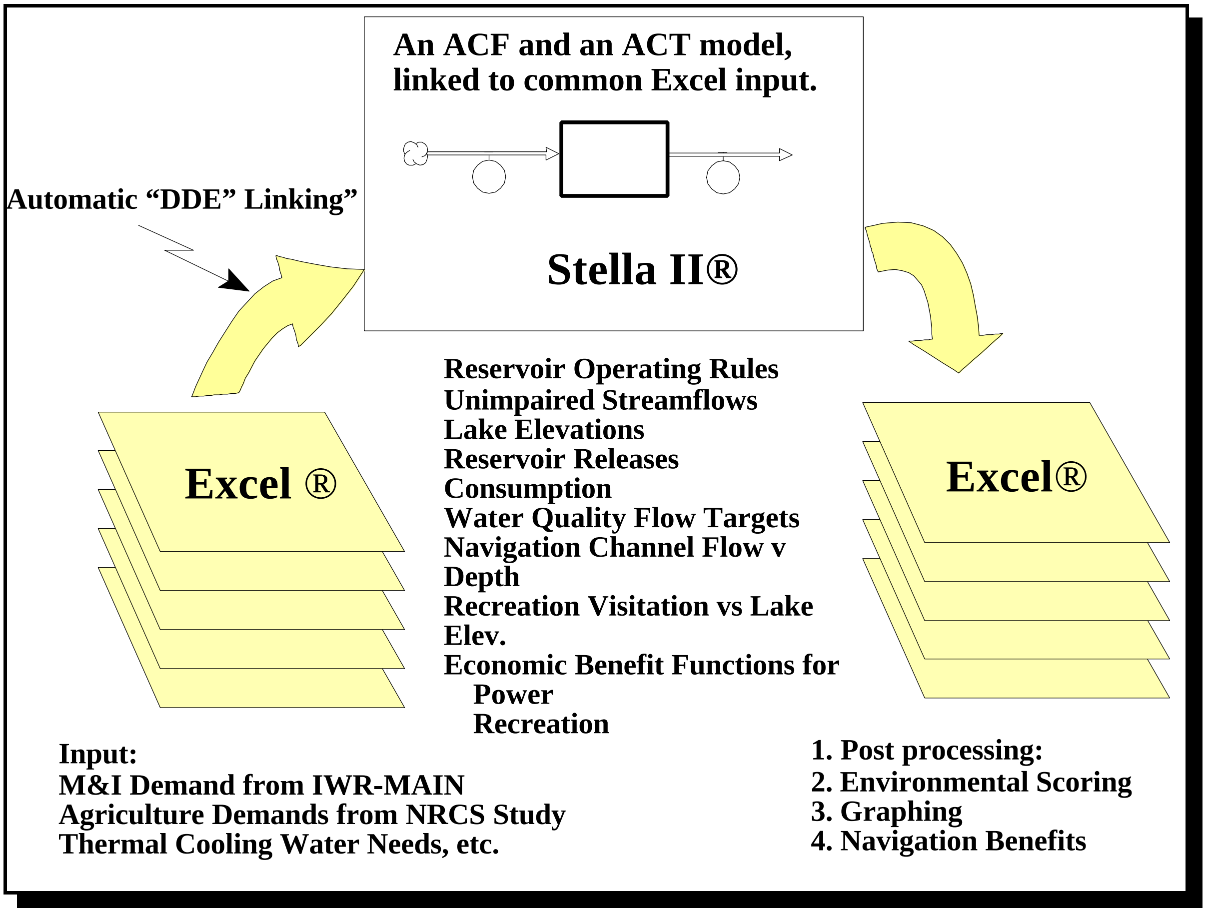

Figure 4. Overview of the ACT-ACF Shared Vision Model, using Stella II® and Excel®

negotiation on how the system should work, not how it does work. As each part is finished, the model becomes a central repository of that to which all agree, and its estimates of system performance become more universally trusted. For those areas where there is real uncertainty, and consensus cannot be reached, modelers can generally use features in the STELLA II® software to determine the sensitivity of system performance to the uncertainty involved.

Technology changed considerably during the Comprehensive Study. At the beginning of the study, Stella II® ran only on a Macintosh® platform. The draft ACT-ACF Shared Vision Model runs under Windows 95®, using one Stella II® model for the ACF, another for the ACT, and a set of Excel® spreadsheets that span both basins and hold much of the demand and control data.

D. Basinwide Study Team

The study partners in the present comprehensive study are Alabama, Florida, Georgia and the Federal government, represented by the Corps of Engineers, Mobile District. The Executive Coordination Committee (ECC) is composed of the District Engineer of the Mobile District and one appointee by each Governor . The ECC approves study funding allocations and sets study goals. The Technical Coordination Group (TCG) is composed of one appointed representative from water management agencies of each of the three states and the Mobile District of the U.S. Army Corps of Engineers. The TCG is responsible for study management and technical decisions.

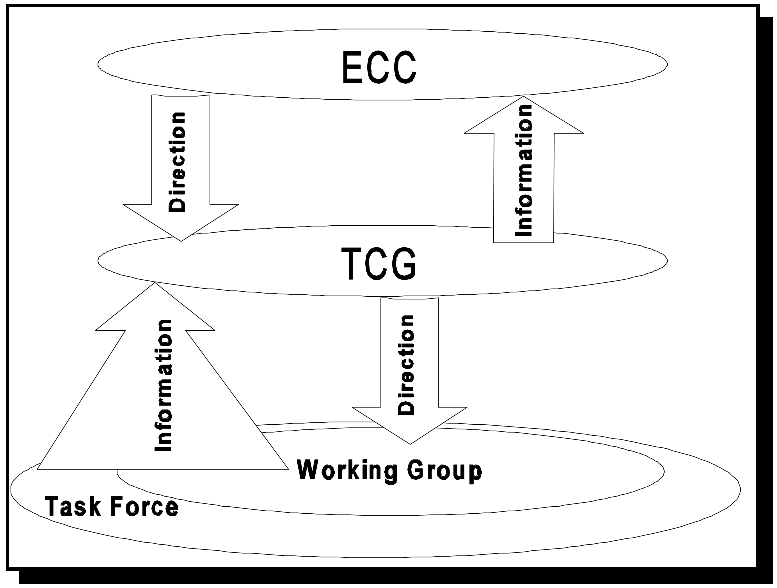

Figure 5. The Basinwide Study Team Organization

Participation in the Basin-Wide Management Study element was organized into several circles. The Corps' Institute for Water Resources led the planning effort in partnership with the University of Washington, which led the shared vision modeling.

The **Basinwide Management Working Group** included IWR and University of Washington team, plus two representatives from each partner. The Working Group guided the development of the shared vision models, debated and formulated recommendations on all major basinwide study issues, and were the primary contact points for stakeholders interested in the basinwide element. The Working Group held 11 workshops, and nearly two dozen teleconferences during the study. Models and documents under review were posted on the University of Washington's Homepage (http://atlas.ce.washington.edu/~actacf/). Members corresponded informally by e-mail on a daily basis. The Working Group advised the TCG on basinwide issues.

The **Basinwide Management Task Force** consisted of approximately 80 stakeholders who had a special interest in basinwide management and agreed to work closely with the Working Group. Task Force members have met twice so far as a group, using the opportunities to learn about each other's work as well as advising the Working Group. Task Force members, in turn, helped keep other stakeholders informed.

III. WATER USES, NOW AND IN THE FUTURE

A. General

Data sources. The basinwide analysis relies on separate water use forecast studies. In addition, these studies also estimated the source of the water (a particular stream or groundwater), and the percent of water withdrawn that would be returned to streams. The forecasts are summarized in this chapter under the headings of Agriculture, Environment, Municipal andIndustrial, Navigation, Electrical Power, Recreation, and Water Quality. In addition to the demand studies discussed in this chapter, the environmental suitability of water flows and stages for rivers, reservoirs, and wetland areas was established, and the economic value of some water uses was also estimated. Those study results are discussed in Chapter IV starting on page 32.

Basin Characteristics. About half the population in these basins lives in Georgia in the Coosa and Chattahoochee subbasins, where water availability - both surface and ground - is most limited. Despite a number of small reservoirs, the Flint River is essentially unregulated, and its contribution to the Apalachicola varies considerably more than the Chattahoochee's. Where groundwater is available, it is generally plentiful, but groundwater pumped along the lower portion of the Flint and in the central portion of the ACT reduces flows in nearby streams.

B. Agriculture

Current Situation. Georgia farmers used about 72% of all agricultural withdrawals in these basins in 1990, while Alabama accounted for 21%, and Florida 7%. This relative share of agricultural water demand among states is not expected to change in the near future. Irrigation in Georgia is primarily in the southwest in the Flint and Chattahoochee Basins (Agricultural Water Demand, 1994). Unlike M&I or thermal withdrawals, practically none of the water withdrawn for agricultural use is returned to streams.

Effects of Reduced Water Supply. Shortfalls in water supply after crops are planted could lead to the loss of crops, but most agricultural water is supplied by groundwater (see **Table 4**), in which case this is unlikely to happen. If farmers are aware of water shortages in advance of a growing season, they can accommodate to some extent by planting crops less dependent on irrigation. Over the long term, though, restrictions on irrigation water supply could constrain the amount of irrigated acreage and the value and variety of crops.

Forecasted Use of Water (1995 to 2050). Water use forecasts are shown in **Table 4**. Agricultural water demand in both basins is expected to increase by about 40%, or 120 mgd between 1990 and 2000. Agricultural use varies substantially from month to month. By the year 2050, agricultural water demand in the peak month is expected to be over 2,500 MGD in the ACF, with average annual use a little over 500 MGD. In the ACT, the peak month's use in 2050 is forecast to be over 600 MGD, with an annual average use of 151 MGD.

Stakeholders. Agricultural stakeholders in these basins include the Alabama Soil and Water Conservation Committee, Alabama Department of Agriculture and Industries, Alabama Farmers Federation, Association of Conservation Districts, Association of Nurserymen, East Alabama Catfish Association, ADECA/OWR, Georgia EPD, Southwest Georgia Regional Development Center, and the Georgia Farm Bureau.

Table 4. Forecasted Agricultural Withdrawals, 1990-2050, Both Basins (MGD)

	Forecast Year					
ACT	1990	1995	2000	2010	2020	2050
Average (surface)	37	44	52	64	74	109
Average (ground)	23	26	30	36	40	55
Average (surface & ground)	60	70	82	100	114	164
Peak Month (Surface)	79	101	126	173	214	352
Peak Month (ground)	42	50	61	80	96	151
Peak (surface & ground)	120	152	187	253	310	503
ACF						
Average (surface)	62	81	88	107	117	153
Average (ground)	187	242	262	318	340	431
Average (surface & ground)	249	323	350	425	456	584
Peak Month (Surface)	239	327	356	447	486	647
Peak Month (ground)	877	1154	1248	1515	1614	2042
Peak (surface & ground)	1117	1481	1604	1962	2100	2689

C. Environment

Current Situation. The construction of reservoirs created lakes, reduced and relocated wetlands, blocked access to upper portions of streams, slowed flow velocities, changed sedimentation, nutrient, temperature and turbidity patterns, smoothed month to month flow variations and (below hydropower dams) increased daily flow fluctuations. The environment in these basins is changing in response to the new physical condition. Some of the changes, such as the creation of several lake fisheries, is seen as desirable. Other changes, such as the depletion of wetlands, have hurt the basins. Accepting the conditions imposed by the reservoirs, there are still environmental concerns.

Most of the significant environmental concerns in these basins, including much of the threat to species diversity, are related to water quality, and many of those concerns are driven by non-point source pollution, a topic outside the plan of the Comprehensive Study. Nonetheless, there are opportunities to improve aspects of the basin environment by varying the timing and magnitudes of water flows, and the success of those changes can be predicted using information developed during the Comprehensive Study and integrated into the basinwide analysis.

Effects of Reduced Water Supply.

Fish and wildlife management facilities in the ACT use about 3 MGD, almost all (2.76 MGD) pumped from groundwater for three hatcheries in the Armuchee River subbasin. Managers at those three hatcheries felt that current water supplies would not meet future needs. In some cases that is because of seasonal problems with water supply availability, and in other cases because of physical limitations of existing pumps.

Fish and wildlife management facilities in the ACF use about 23 MGD, including nearly 20 MGD from the Chattahoochee River for the Buford Trout Hatchery and Eufala National Wildlife Refuge. Managers at these two facilities indicated that current water supplies would be adequate for future needs.

The greatest concern for the future of riverine habitat is that increased agricultural consumption will reduce flows in the Flint and Apalachicola Rivers. This would particularly impact the Bay Sturgeon, a listed species, and the striped bass. Reductions in or modification to the flow regime in the Apalachicola River would affect the input of nutrient and organic matter to or the salinity regime of the Apalachicola Bay. The Bay is an important nursery grounds for the Gulf of Mexico. The Bay produces about 10% of the nations's oysters harvest. The Northwest Florida Water Management District has developed a computerized Bay model. Researchers are attempting to determine the relationship between long term flow regimes and salinity and organism populations in the Bay.

In months with relatively low flows, navigation windows divide the month into days with fairly smooth flows large enough to create the required depth of water for navigation, and days before and after the window in which the flows are generally lower than the monthly average. Some are concerned that the extreme low flow periods may cause increases in disease among some fish.

Stakeholders. Organizations and agencies concerned with the environment include the Alabama Department of Environmental Management, Alabama Department of Conservation and Natural Resources, Sierra Club, Audubon Society, Nature Conservancy, Alabama Conservancy, BASS, Inc., Cahaba River Society, Alabama State Rivers Coalition, Alabama Pulp and Paper Council, Environmental Committee, Alabama Power Company, Environmental Division, ADECA/OWR, Municipal waste water utilities in the study area, industrial dischargers in the study area, Alabama Business Council, Alabama Development Office, State of Florida, Northwest Florida Water Management District (NWFWMD), Georgia EPD, Georgia Conservancy, Upper Chattahoochee River Keepers, and federal agencies, especially the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency.

D. Municipal and Industrial

Current Situation. During the 1980's droughts, Atlanta and other municipalities in the ACT and ACF basins had to institute drought response measures to deal with shortfalls in water supply.

The Atlanta Metro region is among the fastest-growing in the nation and is almost totally dependent on water from the Chattahoochee and Coosa River basins, including Lakes Lanier and Allatoona. Metro Atlanta straddles the ACT, the ACF, and on the east, the Altamaha-St. Marys River basin. Water supply is from the ACT and ACF; water is returned to all three basins. Several communities in the Piedmont region of Georgia have had critical municipal and industrial water shortages during the past drought and have evaluated options for local and regional reservoirs for surface water storage. The five-county West Georgia region has wanted to share a cost-effective surface water supply from the Tallapoosa River basin in Haralson County. Several of these counties have few options for future municipal and industrial water supplies.

Effects of Reduced Water Supply. When faced with cutbacks due to droughts or water supply emergencies, municipal users will temporarily forgo some benefits such as green lawns and clean cars in order to conserve water. Industrial users will accommodate to water shortages, too, but usually by increasing their expenditures for water. Because water is generally an inexpensive portion of their overall costs, it makes sense in many cases to make investments such as intake pipe extensions or long term conservation to reduce vulnerability to drought. When declarations of drought last too long or happen too often, cities around the United Stages have responded, usually with investments in water supply facilities and conservation, and, in rare cases, constraints on growth.

Alabama is concerned that Georgia’s growth in the near future will deprive Alabama of the water it would need for growth in the more distant future.

Forecasted Use of Water (1995 to 2050). Forecasts of M&I water use in these two basins were made using IWR-MAIN Water Demand Analysis Software, Version 6.1® (Municipal and Industrial Water Use; 1996). This software estimates future water use as a function of housing, employment, and other demographic and climate data. This is an advance over earlier projection methods which assumed *per capita* use would remain constant, making future water use proportional to population increases. **Table 5** shows the forecasted average and peak month water *withdrawals* from both basins, and from surface and ground sources for municipal and industrial use through 2050. The forecasts for these two basins reflect an increase in residential use pushed by an increase in the number of households in the basins. Demand will be moderated by the future effects of recently enacted conservation measures, and a decline in the use of water for manufacturing because of production efficiency and a sharp decline in manufacturing employment in the region. The net result is that M&I water use in these two basins is expected to rise by less than a third while population almost doubles. About 40 percent of the withdrawals shown in **Table 5** are returned to ACT and ACF rivers.

Figure 6 and **Figure 7** show the effect that recently enacted water conservation efforts will have on forecasted *demand*[2] for M&I water is these two basins. The lower, "expected" forecast reflects the decline in future water use estimated by IWR-MAIN® as a result of the conservation measures put in place between 1990 and 1994. For example, the U.S. Energy Policy Act of 1992 requires that toilets manufactured for residential use consume no more than 1.6 gallons per flush. As 3½ and 5 gallon per flush toilets in existing homes are replaced, water use will be lowered. The "expected" forecast also includes the effects of water price increases from 1990 to 1994.

The higher ("No Conservation") estimate reflects what water use would be without these recent conservation measures. Both estimates increase in the future, a result of a sharp increase in the number of households, and despite a decline in manufacturing employment.

Stakeholders. Municipal and industrial stakeholders include the Atlanta Regional Commission, and regional Development Centers throughout Georgia, the Alabama Department of

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[2]. There is a small difference between the totals in **Figure 6** and **Figure 7** and the totals in **Table 5** because the figures include a small amount of M&I water demand satisfied by sources outside these two basins, and **Table 5** shows ACT and ACF withdrawals for M&I, a small portion of which are used to satisfy demand just outside the study area.

Environmental Management, Alabama Water and Sewer Institute, Alabama Rural Water Association, water utilities in the study area, Business Council of Alabama, Alabama Textile Association, Alabama Pulp and Paper Council, Alabama Chemical Association, regional planning and development commissions, local chambers of commerce, Georgia EPD, public water system managers, industries, and Rural Development Corporations.

Table 5. Forecasted Municipal and Industrial Withdrawals, 1990-2050 (MGD)

	Forecast Year					
ACT	1990	1995	2000	2010	2020	2050
Average (surface)	636	709	750	838	836	855
Average (ground)	114	131	147	180	193	208
Average (surface & ground)	750	840	896	1019	1029	1063
Peak Month (Surface)	676	753	796	890	888	908
Peak Month (ground)	124	141	158	194	208	225
Peak (surface & ground)	800	895	955	1084	1096	1133
ACF						
Average (surface)	661	700	728	799	818	837
Average (ground)	91	94	96	104	106	115
Average (surface & ground)	752	794	824	903	924	951
Peak Month (Surface)	723	766	798	876	897	924
Peak Month (ground)	101	104	106	115	117	124
Peak (surface & ground)	824	870	904	991	1015	1051

Figure 6. ACT Expected M&I Conservation

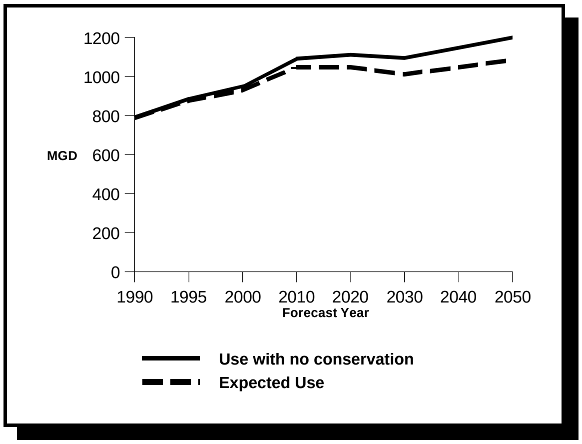
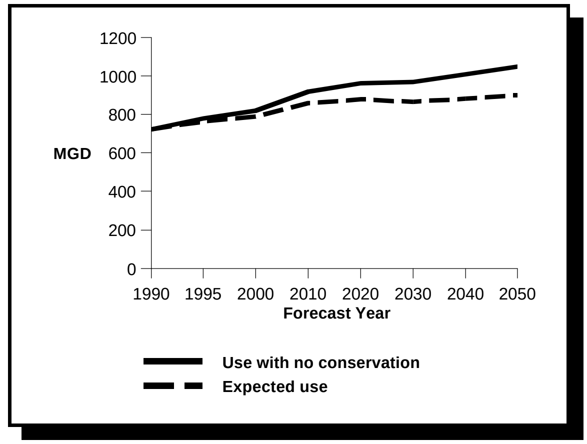


Figure 7. ACF Expected M&I Conservation



E. Navigation

Current Situation. Locks and channel modifications (see **Figure 8**) were part of the original ACF and ACT projects authorized by the U.S. Congress. The channels are used by recreational boaters and commercial tows (one or two barges). The availability of navigation typically reduces transportation costs, a benefit of national importance.

The ability to use barges in each basin depends on having enough depth (at least 7 feet, and preferably 9 feet). Upstream of locks and dams, water depths can be maintained by replacing the water lost through lockage, evaporation, and reservoir releases. But in the reach below Claiborne Lock and Dam on the ACT, and below Jim Woodruff Lock and Dam on the ACF, adequate depths require a combination of annual dredging and high flows (see **Figure 9** and **Figure 10**) because these sections flow freely into bays . Channel reliability has been lower than predicted when these projects were proposed because the flows necessary to produce a nine foot depth have increased, and because the amount of water available is less than supposed during reservoir design. Use of both the ACF and ACT channels dropped considerably after the 1980's, when droughts reduced depths too often. As more water is used for cities and farms, the commitment to navigation could deteriorate more.

When there is not enough water in ACF reservoirs to maintain adequate navigation depths throughout the whole month, the Corps releases that month’s allotment of water over just a portion of the month. These navigation “windows” are scheduled and typically provide adequate navigation depths for 12 days.

Effects of Reduced Water Supply. There is both a long and short term effect from reduced water supply for navigation. Uncertainty about channel reliability makes long term investments in storage, docking and loading facilities less attractive. If shippers feel the channel will not be available, many will commit to other forms of transportation. Those who have made a long term commitment to navigation also suffer short term impacts when channel depths are less than 9 feet. Although it costs essentially the same amount to use a barge whether it is loaded for a 7½ or 9 feet depth, a barge loaded for a 7½ foot deep channel carries less cargo.

Forecasted Use of Water. Flows required to provide different depths of water in the navigation channel were estimated based on hydraulic analysis and review of recent field data. These estimates were assumed to remain constant over the planning period, although the amount of water needed to maintain a 9 foot depth in these channels has increased over the years as the channel has widened from erosion. The required flows required in the ACT channel for each calendar month for various depths from 7.5 to 9 feet are shown in **Figure 9**. The required flows for the ACF are shown in **Figure 10**. (Flow-depth relationships provided by Mobile District Corps of Engineers for the ACT-ACF Comprehensive Study).

The flows needed to provide a given depth vary during the year because of the cyclical accumulation and dredging of sediment. The lower flows shown in **Figure 9** and **Figure 10** for the late summer reflect typical sedimentation and dredging patterns. However, sedimentation varies from year to year and dredging performance is a function of funding availability, weather, and mechanical failures. because of all of this, the flows required in a specific year may vary from the typical patterns shown in this section, and later in the report, in the discussion of structural alternatives to the current channels. Nonetheless, without an estimate of the typical annual pattern, it would be impossible to compare the costs and benefits of different plans or to estimate the effects on other uses of reservoir releases for navigation.

Stakeholders. Navigation stakeholders include local chambers of commerce, Alabama Development Office, Alabama State Docks, the Coosa-Alabama River Improvement Association, the Tri-Rivers Waterway Development Association, Business Council of Alabama, Georgia EPD, Georgia Ports Authority, Southwest Georgia Regional Development Center, Georgia Farm Bureau, Southwest Georgia Chambers of Commerce, and Southwest Georgia industries.

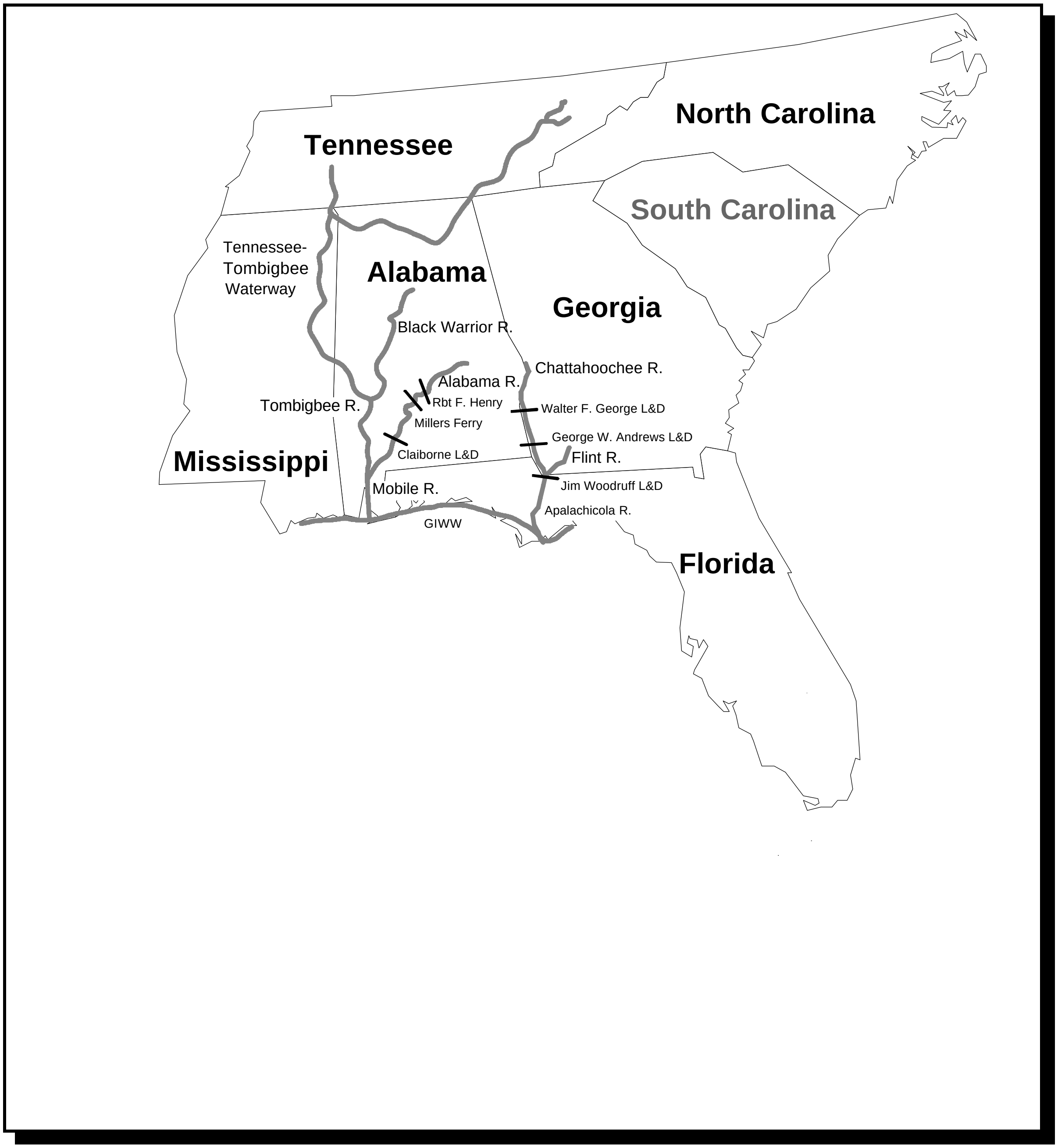


Figure 8. ACT and ACF Navigation Projects

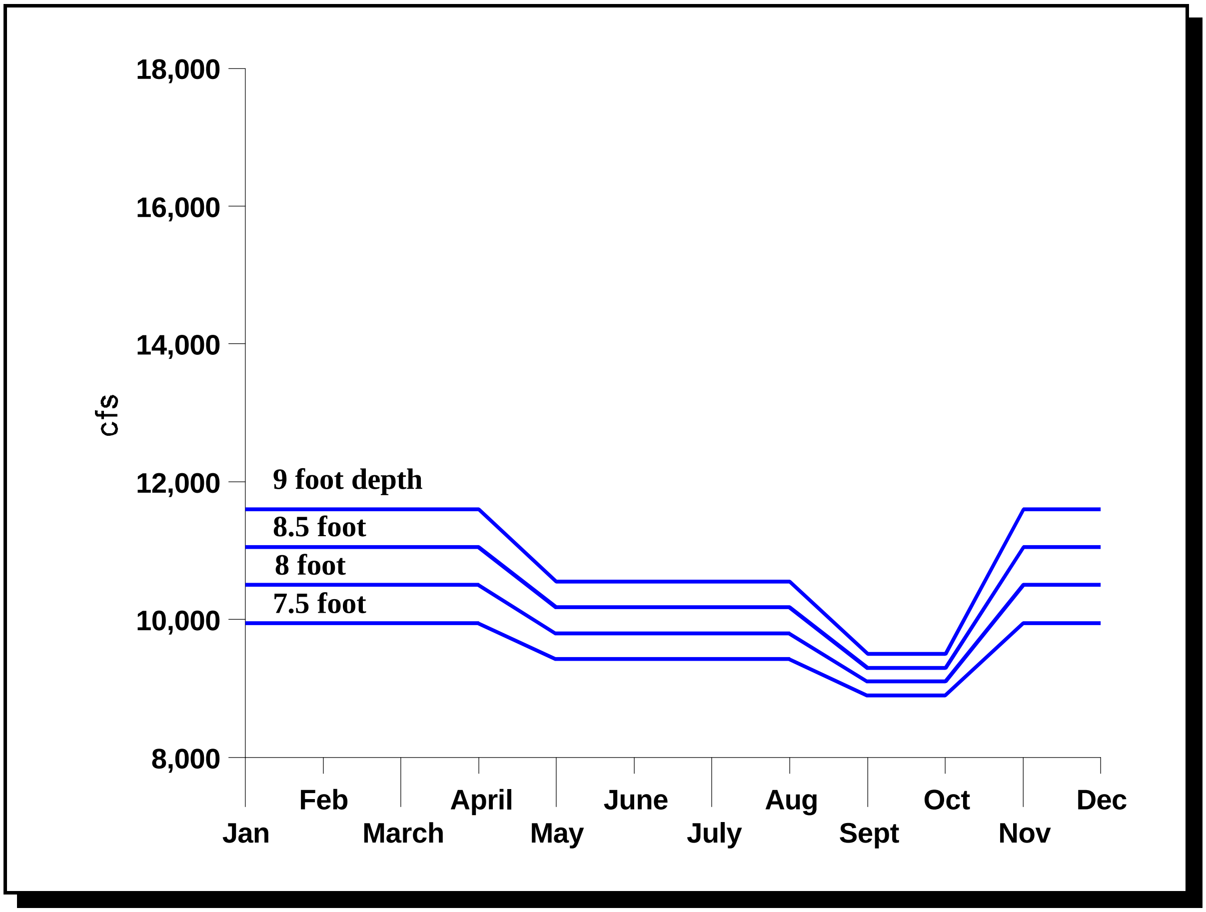


Figure 9. Current Monthly Flows Needed for the ACT Below Claiborne.

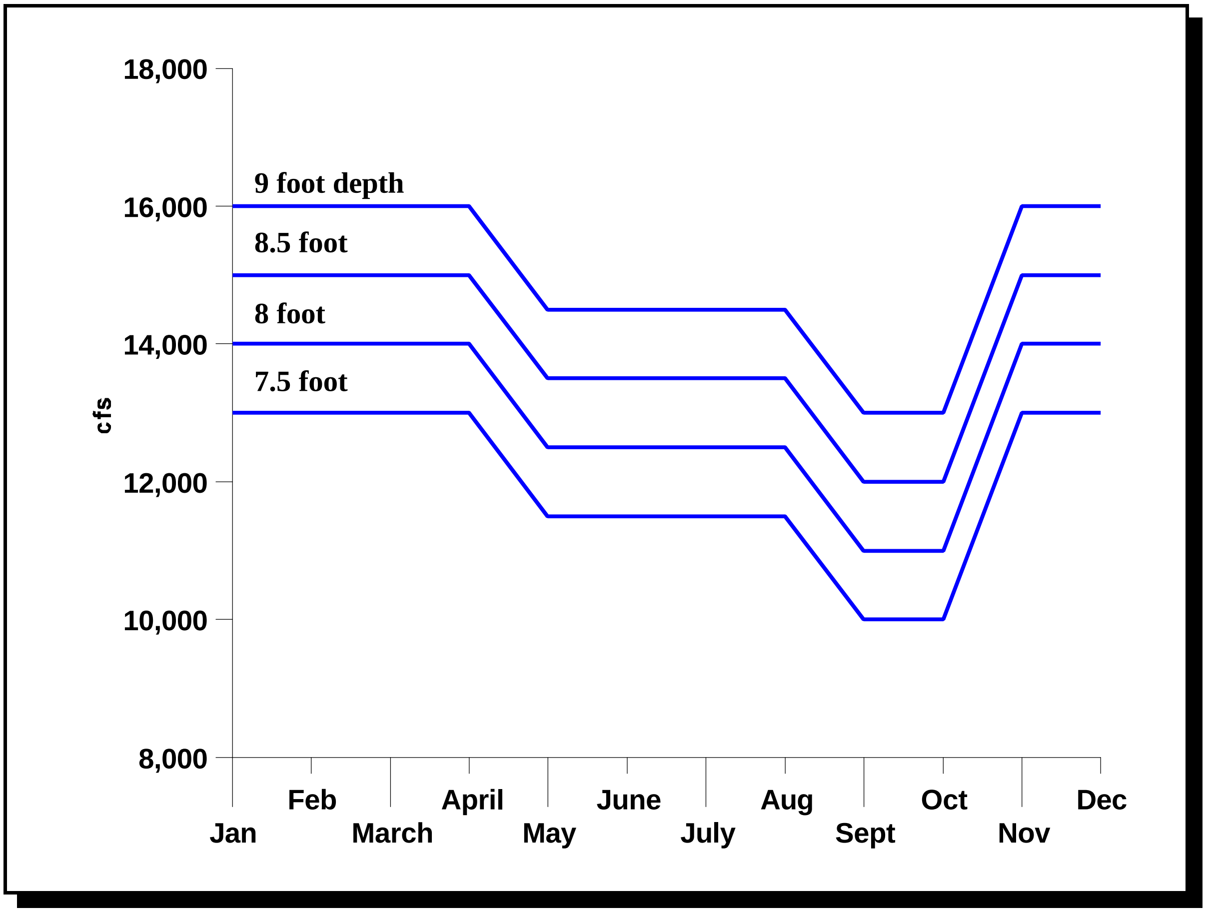


Figure 10. Current Monthly Flows Needed for the ACF Below Jim Woodruff.

F. Electrical Power

Current Situation. Water is needed for the production of hydropower, and for the cooling and process water used for thermal generation plants. Withdrawals for thermal power exceed withdrawals for all other uses combined, especially in the ACT basin, but consumptive use is much less, since much of this water is returned to the stream from which it was withdrawn after it is used in the plant.

Effects of Reduced Water Supply. Hydropower is an ideal way to respond to the peak energy demands customers impose near the middle of the day; operational costs are very low, and the plants can be brought up and down very quickly. But the contribution that hydropower plants can be ***depended on*** to provide is defined by the amount of power provided during a severe drought. If water management changes or competitive consumptive use reduces the dependable capacity provided by hydropower, that capacity must be replaced with additional non-hydro plants, or with energy “wheeled” in from other regions. Thermal plants require reservoir or stream levels to be at a certain elevation; when water levels drop too low, intakes must be extended and lowered.

Forecasted Use of Water (1995 to 2050). Hydropower production does not consume water; thermal production does. Water withdrawal and consumption rates for thermal power plants were developed by the Power Resources Task Force, using baseline data from the Water Use Inventory Report prepared for the Comprehensive Study. These estimates are shown in **Figure 11** and **Figure 12**.

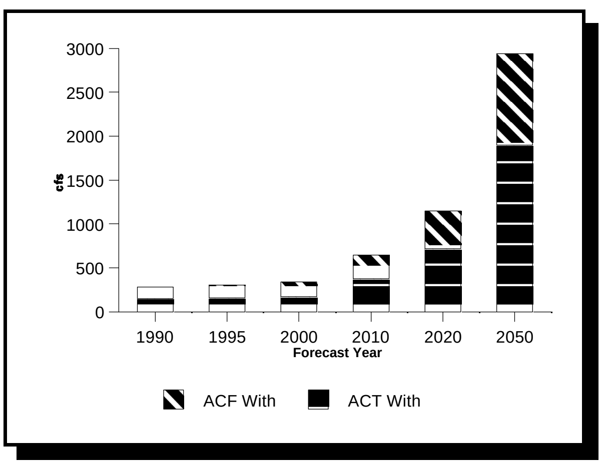


Figure 11. Thermal Power Withdrawals

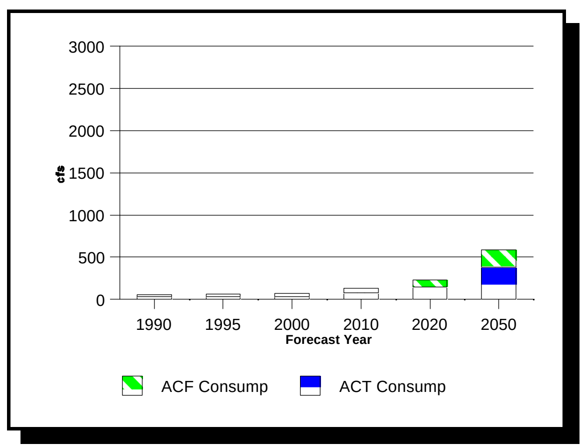


Figure 12. Thermal Power Water Use

Stakeholders. Stakeholders in the production of power include the Southeast Power Administration, Preference Customers, Oglethorpe Power, Georgia Power, ADECA/OWR, Alabama Department of Conservation and Natural Resources, Alabama Public Service Commission, Alabama Power Company, Alabama Electric Co-Ops (all in study area), Alabama Municipal Electric Co-Op, and the Southern Company.

G. Recreation

The Current Situation. The ACT and ACF lakes are popular recreation sites. There is also extensive recreational use of the rivers and estuaries in Florida, especially for fishing. Recreational use of estuaries, especially the Apalachicola, is extensive and an important component of local economies.

Effects of Reduced Water Supply. As reservoirs such as Lake Lanier, Allatoona, and Carters are drawn down, they become less attractive and less accessible for recreation activities. Drawdown of reservoirs increases the distances from the lake to homes and other viewing locations, and causes aesthetic problems by exposing mud flats. Such drawdowns may result from utilizing the storage in the reservoir to supplement river flow during time of drought.

Forecasted Use of Water (1995 to 2050). Recreation does not consume water, but the retention of water in reservoirs for lake recreation could keep other users (such as navigation or M&I) from getting water from reservoir releases. Although the number of recreation visits is expected to grow in proportion to regional population increases, the amount of water needed for lake recreation will not increase; the lakes will just become more crowded.

Stakeholders. Recreational stakeholders include lake and boat owner associations on rivers and reservoirs in Alabama, tourism development councils in study area, Alabama Department of Travel and Tourism, recreation vendors, State Department of Parks and Industry, Georgia Department of Natural Resources (Parks Division), Georgia EPD, Lake Lanier Property Association, Marine Trade Association, local chambers of commerce, Council of Economic Development Organization, and many recreation and tourism groups in Florida.

H. Water Quality

Current Situation. Water quality problems stem primarily from treated wastewater discharges, discharges of untreated sewage into caused occasionally by overflows of combined storm and sanitary sewer systems, and non-point source pollution. The U.S.G.S. reports[3] that from 1983 to 1993, phosphorus loading into the Chattahoochee River declined by about 83% because of wastewater treatment plant improvements and a ban on phosphorous containing detergents. As of the date of the U.S.G.S. report, 9 of the 12 wastewater treatment plants between Lanier and West Point that treat more than 1 MGD met a Georgia EPD Administrative Order to reduce average concentration of phosphorus to 0.75 mg/L or less. The three remaining plants, owned by the city of Atlanta, negotiated an extension for compliance, in return for an agreement to meet a more restrictive standard (0.64 mg/L). Improvements in wastewater treatment facilities and

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[3]. Wangsness, D.J.; E.A. Frick, G.R. Buell, J.C. DeVivo. Effect of the Restricted Use of Phosphate Detergent and Upgraded Wastewater-Treatment Facilities of Water Water Quality in the Chattahoochee River near Atlanta, Georgia; U.S. Geological Survey, Open File Report 94-99, 1994.

construction of new separate sanitary and storm water systems will help counter the effects of higher rates of M & I wastewater returns and continuing non-point source runoff in the future. The water quality demand scope of work for the ACT/ACF Study will provide only a coarse screening of basinwide water quality. Each of the partner states has been delegated responsibility to set water quality standards and to establish NPDES discharge limits to meet these standards, subject to review by EPA for compliance with Federal requirements.

Effects of Reduced Water Supply. Increased future consumptive demands could simultaneously increase loadings and reduce diluting stream flows.

Forecasted Use of Water (1995 to 2050). Increases in M&I and agricultural water use will increase potential effluents and concentrations. These may be offset by improvements in wastewater treatment. The partners have indicated a desire to maintain at least the current level of flows at Peachtree Creek and Columbus, GA.

Stakeholders. Stakeholders interested in water quality include the Alabama Department of Environmental Management, Alabama Department of Conservation and Natural Resources, Sierra Club, Audubon Society, Nature Conservancy, Alabama Conservancy, BASS, Inc., Cahaba River Society, Alabama State Rivers Coalition, Alabama Pulp and Paper Council, Environmental Committee, Alabama Power Company, Environmental Division, ADECA/OWR, Alabama Water and Sewer Institute, municipal wastewater utilities in the study area, industrial dischargers in the study area, Alabama Business Council, Alabama Development Office, Georgia EPD, Georgia Public Water Supply and Wastewater Systems, Industries, Georgia Conservancy, Regional Development Centers, Downstream Users, U.S. EPA

IV. MANAGEMENT OBJECTIVES AND METRICS

In Shared Vision planning, participants identify their objectives and develop quantifiable measures of how well their objectives are met by current and alternative plans. The partners were asked to identify five sorts of management variables: decision criteria, planning objectives, performance measures, effects, and constraints.

A. Decision Criteria

On what basis will decision-makers determine which plan they prefer? For this draft, the Corps decision criteria were inferred from general publications, and Alabama's were deduced from their public support for reliable navigation and an equitable apportionment of water. Georgia and Florida offered explicit decision criteria.

Georgia's criteria are shown in **Table 6**. Florida has stated that the major criterion it will use in comparing alternatives is the similarity in the resulting Apalachicola River flows and inflows to Apalachicola Bay to historic flows.

Although there are more than 60 federal statutes that may drive, regulate or constrain water management decisions, the most significant criteria and procedures the Mobile District will use in the selection of ACT and ACF alternatives are contained in the laws authorizing construction of these reservoirs, the <u>Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies</u> (the P&G) (1983), the National Environmental Policy Act (NEPA) of 1969, and the Clean Water Act (1977).

Table 6. Georgia Decision Criteria

1. Most importantly, does the alternative meet 2050 M&I and agricultural demands from current sources; or, if not, with new or increased transfers?
2. Does the alternative support instream flows >= 750 cfs in the Chattahoochee at Peachtree Creek and >= 1,150 cfs in the Chattahoochee at Columbus?
3. Does the ACT alternative (or ACT-ACF alternative) produce minimum flows in the Tallapoosa and Coosa Rivers at the Alabama border that are at least sufficient to meet water quality standards?
4. Does the alternative meet targets for recreation, hydropower, navigation, and wastewater assimilation to the extent possible, consistent with the highest economic value and optimum environmental value?

Congress authorized the construction of the Corps reservoirs in the ACT and ACF basins for specific purposes such as flood control, navigation, and hydroelectric power. In addition, the Corps can support recreation and water quality releases to the extent that the specifically authorized purposes are not significantly affected. A measure of the degree to which a Corps reservoir is managed for one purpose or another is the amount of space within the reservoir ***allocated*** to store water for that purpose.

The Corps can consider changes in those allocations after the project is built. Typically, the Corps has reallocated storage to municipal and industrial uses. Congressional approval is generally required[4]. Although Congress may decide to reject or modify the Corps recommendation the Corps is required to make a recommendation based on a benefit and cost sharing analysis.

Economic effects have been a principal decision criterion for the Corps of Engineers since the 1930's. The Corps will consider costs, economic and environmental effects, performance in meeting the partners planning objectives, and cost sharing requirements in making recommendations regarding its existing or new Corps projects (such as additional navigation locks) in these two basins. Economic and environmental effects would also be considered in Corps regulatory decisions under the Clean Water Act regarding new non-federal reservoirs.

When there are no separable storage costs for recreation, operation for recreation is secondary to operation for purposes for which the storage was allocated. Congressional authorization would be necessary if reallocation to provide more stable recreation levels would have a significant effect on other authorized purposes. Similarly, changes in reservoir operating rules to provide water quality releases would require Congressional authorization if doing so would significantly affect the originally authorized purposes.[5] IWR queried several senior Corps staff members, and none were aware of a reallocation of storage in a Corps reservoir to recreation.

B. Planning Objectives

Planning objectives are formally structured statements that concisely express how and when stakeholders would like to affect a specific water use in a specific place. In practice, the achievement of one objective (for example, to increase the production of hydropower in the ACT-ACF system) may not be consistent with the achievement of another (to increase recreation at Lake Lanier), but achievement of both is desired. Planning objectives are listed in **Table 8** to **Table 14**.

C. Performance Measures

Performance measures related to each planning objective are also shown in **Table 8** to **Table 14**. Performance measures provide a quantitative assessment of how well an alternative meets an

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[4] Small reallocations to M&I do not require Congressional approval. Providing the criteria of the 1958 Water Supply Act are not violated, 15 percent of total storage capacity allocated to all authorized project purposes or 50,000 acre feet, whichever is less, may be allocated from storage authorized for other project purposes or may be added to the project to serve as storage for M&I water supply at the discretion of the Chief of Engineers. The division commander can approve reallocations up to 499 acre-feet.

[5] U.S. Army Corps of Engineers. Digest of Water Resources Policies and Authorities (EP 1165-2-1, 15 February 1996). Paragraph 17-3e., page 17-5.

Table 7. Preferred Reservoir Recreation Water Levels, ACT and ACF

Reservoir	Preferred minimum elevation[1]
Lanier	5
West Point	3
W.F. George	3
Allatoona	3
Carter's	3
H.N. Henry	3
Weiss	3
Harris	3
Martin	3
Logan Martin	3

1 - In feet below the top of the conservation pool. Flood water is occasionally stored above the conservation pool.

individual planning objective. Two common measures are *reliability* and *vulnerability*. Reliability is the percentage of time a demand is fully met. Vulnerability is the average shortfall during those times when a demand is not met. These general definitions can be applied specifically to each water use. In this study, M&I reliability is measured as the number of months in which the full M&I demand was met divided by the total number of months in the analysis period. M&I, agricultural, and thermal water supply vulnerability is defined as the average difference between the full demand and the amount actually supplied, in millions of gallons per day (MGD). The average is calculated by dividing the total shortfall over the entire period of analysis by the number of months in which there was a shortfall. Lake recreation reliability is defined as the percentage of months in which lake levels were above a user defined impact level (see **Table 7**). Vulnerability is defined as the average depth below that level to which a lake falls during the impacted months.

Navigation reliability is the percentage of months a given depth (7½, 8, 8½, or 9 feet) was achieved, and is reported at two levels of service. Full navigation reliability is the percentage of months a particular depth was available for the entire month (not just during a window). Windows reliability is the percentage of months navigation was available at a certain depth for a window *or* an entire month, and so tends to be a higher number. Navigation vulnerability is the average amount by which a flow was insufficient to provide one of those four depths.

Other performance measures used in this study are the estimated number of recreational visitor-days, and the minimum flows at Columbus and state line Coosa/Tallapoosa. The recreation study is not finished, but the format for the visitation functions that will be used is shown in **Figure 13**.

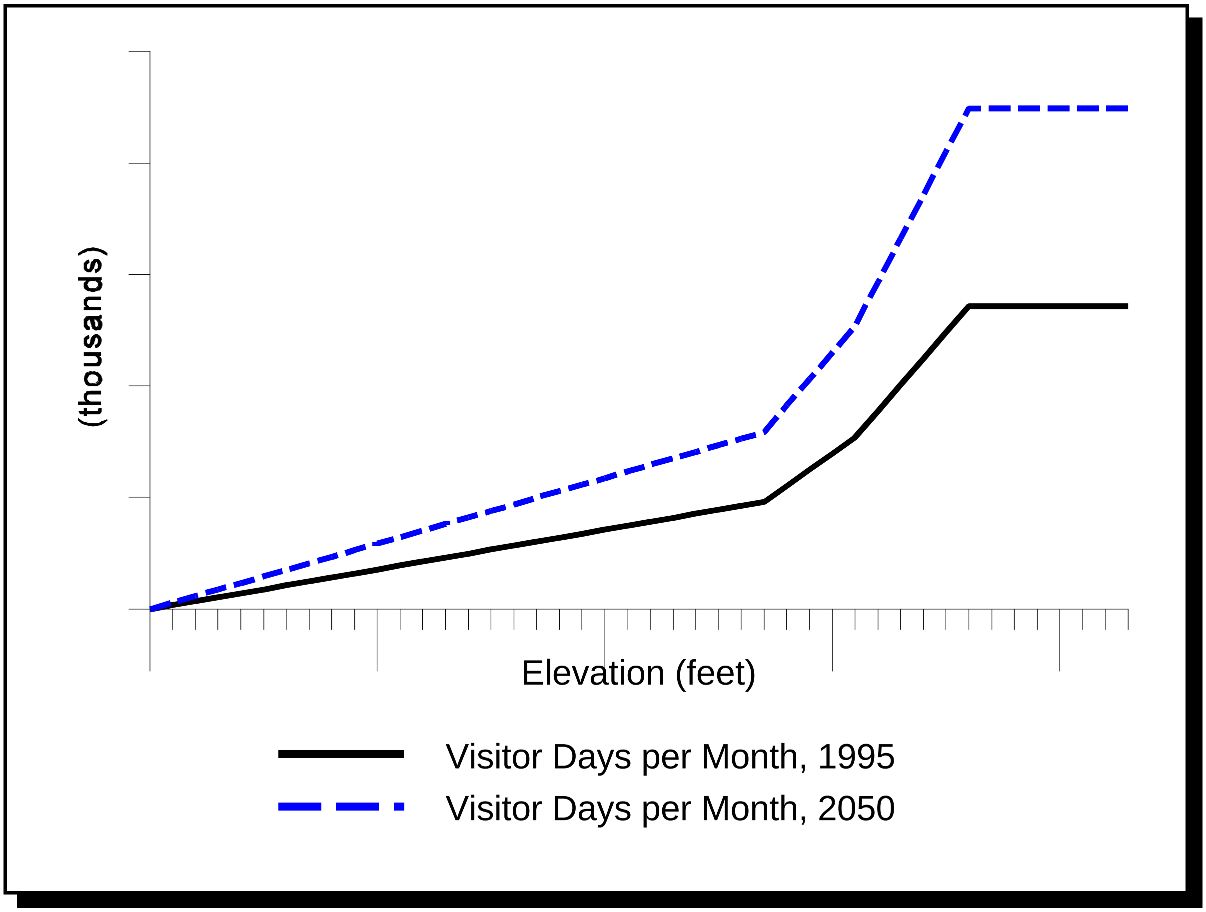

Figure 13. Visitation will be linked to elevation

Minimum flow statistics on the Coosa and Tallapoosa Rivers at the Alabama-Georgia state line, and at Columbus, Georgia on the Chattahoochee River will provide a measure of how much water Alabama will have for future growth

Table 8. Agricultural Planning Objectives and Performance Measures

Planning Objectives

Provide a reliable source of water for current and future agricultural water use opportunities in all three states.

Measures of Performance

Reliability and Vulnerability of the Supply of Agricultural Water

Reliability is the percentage of time the need for water is met completely

Vulnerability is the average shortfall, in MGD, when supply is inadequate

Table 9 Environmental Planning Objectives and Performance Measures

Planning Objectives

Protect or enhance riverine habitat quality
Protect or enhance lake fisheries
Maintain or improve populations of listed species (threatened, endangered, candidate, and sensitive)
Sustain the Apalachicola Bay ecosystem

Performance Measures

Minimum, maximum, average and standard deviations of flows into Apalachicola Bay each calendar month.

Water supply needs for hatcheries are always met (there are some potential groundwater shortages at specific sites, but these are not in the Shared Vision Model). However the environmental effects of different flow and reservoir patterns are rated for riverine, wetland, and reservoir fisheries (see page 35).

Table 10 M&I Planning Objectives and Performance Measures

Planning Objectives. To maintain the highest reliability of M&I supply

Performance Measures

Reliability and vulnerability of M&I supply at 11 measurement points in the ACF (see Figure **Figure 21**, page 43) and 23 measurement points in the ACT (**Figure 20**, page 42).

Table 11 Navigation Planning Objectives and Performance Measures

Planning Objectives

Increase navigation by increasing the reliability of adequate ACF and ACT shipping depths

Increase navigation by extending the ACT channel to Rome, Georgia

Performance Measures and Effects

Reliability and vulnerability of flows at Blountstown (ACF) and Claiborne (ACT)
Tonnage hauled (ACT, ACF)
Transportation savings (ACT, ACF)

Table 12 Electrical Power Planning Objectives and Performance Measures

Planning Objectives

To maintain the highest reliability of water supply for thermal generation
To maintain the highest hydropower energy and capacity during critically dry periods

Performance Measures and Effects

Minimum energy produced from hydropower
Dependable capacity from hydropower
Economic benefits from hydropower
Reliability and vulnerability of water supply to thermal plants

Table 13 Recreational Planning Objectives and Performance Measures

Planning Objectives

To keep reservoir levels above the levels at which recreation is impacted whenever possible.
To manage stream flows to improve recreational opportunities

Performance Measures and Effects

Reliability and vulnerability of suitable recreation lake levels
Recreational visitation
Economic benefits from recreation
Regional revenue from recreation

Table 14 Water Quality Planning Objectives and Performance Measures

Planning Objectives

To improve the ability to dilute wastewater discharges into these rivers.

Performance Measures and Effects

Reliability and vulnerability of meeting flow targets at Peachtree Creek and Columbus, GA.

D. Effects

Taken together, the performance measures discussed in the last section indicate the degree to which water will be available for an individual use. But what is the effect of that performance and the economy or the environment? Those effects are gaged in a variety of ways in the Comprehensive Study, including the estimation of changes in economic efficiency and revenues, and habitat suitability indices. Effects that span more than one water use can be helpful when tradeoffs have to be made between uses. Measuring economic effects can help users determine whether they would trade (for example) a loss in navigation reliability for an increase in hydropower production. The estimation of effects can show which alternatives help the basin as a whole, and can help suggest refinements in an alternative which creates an overall benefit but hurts some stakeholders.

Functions for the economic effects of hydropower production, navigation, and recreation will be calculated in the Comprehensive Study. Those functions are not complete yet. In addition, some preliminary cost estimates were prepared for the costs of aggressive municipal water conservation programs and some navigation channel modifications. The format for economic benefits for ACF navigation are shown on page 33, and the format for recreation benefits is shown on page 34.

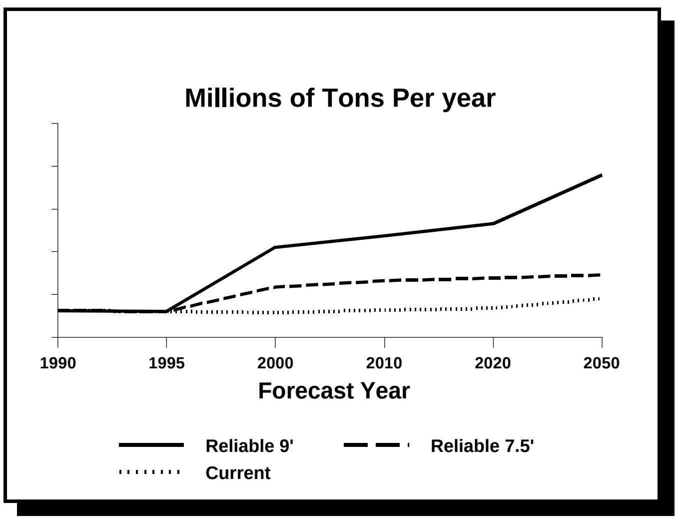

Figure 14. Tonnage Forecasts Are Being Made

Economic benefits from navigation. Lowering transportation costs increases economic efficiency, a benefit to the nation as a whole and to the three state region. Navigation benefits are calculated as the product of the dollar savings per month per ton times the number of tons shipped.

A study (Navigation Benefits, unpublished) will estimate both the tonnages and related benefits. Interviews of shippers conducted during that study suggest that considerably greater tonnage would be shipped (rather than sent on rail) if shippers could be assured of always having 9 feet or even 7 ½ feet of depth. This is because of the large investment in cargo handling facilities navigation requires. These investments are not economic if they must be supplemented with an alternative system for the months in which the channel is not available. **Figure 14** illustrates how the forecasted tonnages for three policies might vary over time.

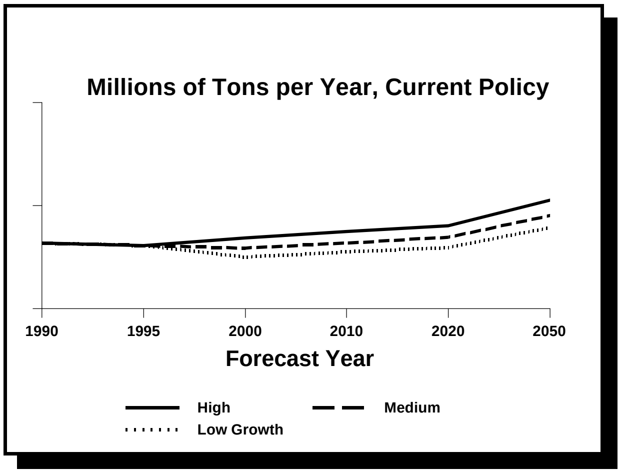

Figure 15. Tonnages Will Be Forecast for Three Economic Assumptions

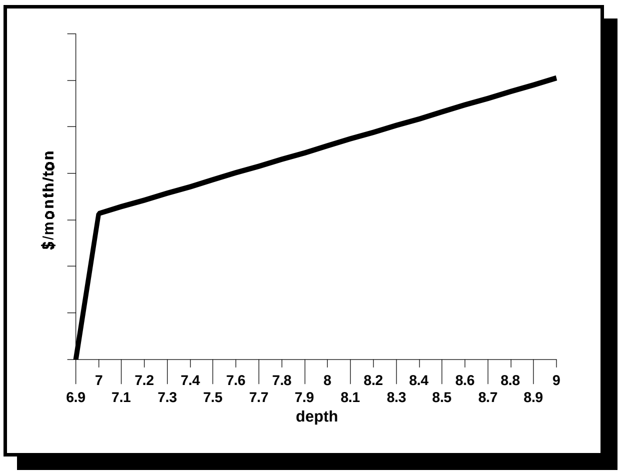

Figure 16. Format Navigation Benefits vs. Depth

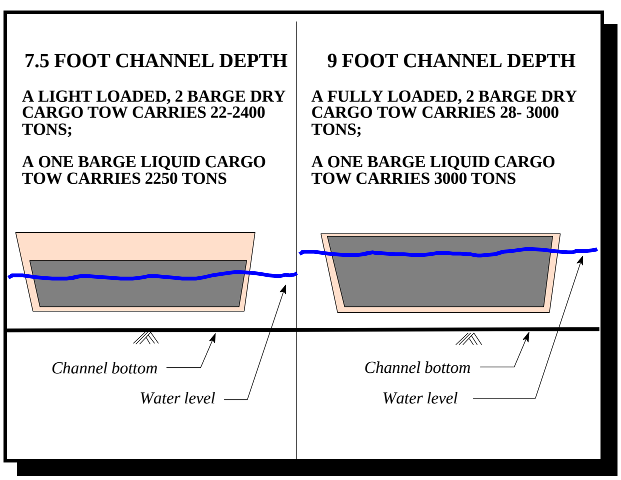

Figure 17. 9 foot depths reduce transport costs

The amount of tonnage shipped is also dependent on the rate of economic growth in the region. Estimates of tonnage shipped under low, expected, and high growth rates will be made for each policy. (**Figure 15**).

There is also a benefit under the "current" or the "guaranteed 7½ foot" policy to greater channel depths in any month, even if those depths are not guaranteed for the entire period of analysis. **Figure 16** shows that the dollar benefit per ton hauled per month increases as a function of channel depth. Although greater depths of water in a given month will not increase the amount shipped, it will reduce the number of barges needed to ship the same tonnage (**Figure 17**).

Economic benefits from hydropower. As of the date of this draft, the economic functions for changes in hydropower production have not been completed.

Hydropower plants provide an economic benefit both from the value of energy produced and from the investment savings because hydropower can provide peaking power that would otherwise have to come from another generating source. In determining the feasibility of new hydropower plants, these benefits are compared to the costs of adding turbines. In the Comprehensive Study, no new hydropower plants were considered, but estimates are being made of the ***loss*** of energy and capacity benefits that occur when water is used for competing purposes.

Economic benefits from recreation. The economic benefits created by recreational opportunities at Corps reservoirs could be an important factor in determining the allocation of storage for recreation.

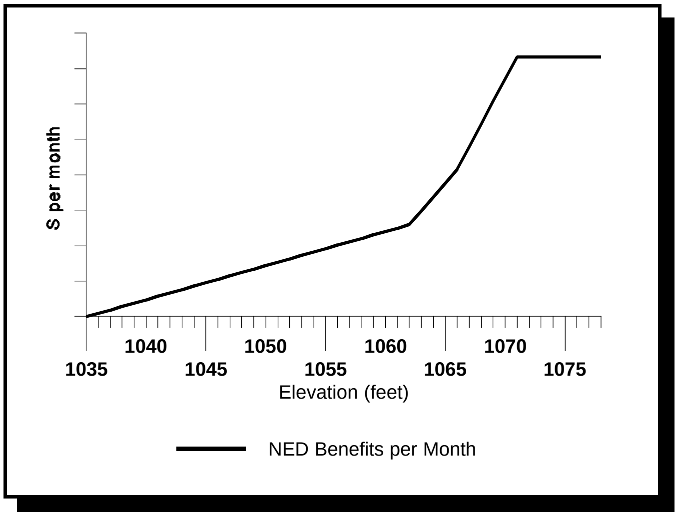

Figure 18. NED Benefits From Recreation (format)

National Economic Development (NED) benefits for recreation are measured in terms of "willingness to pay", which can be estimated in a number of ways. The Corps Waterways Experiment Station (WES) has surveyed potential users of these lakes and will produce estimates of how the number of visitors will change as the lake elevations change in each demand year (see **Figure 13**, page 28). WES will also provide weighted dollar values per visitor day for the NED benefits (**Figure 18**), as well as regional and local revenue (**Figure 19**).

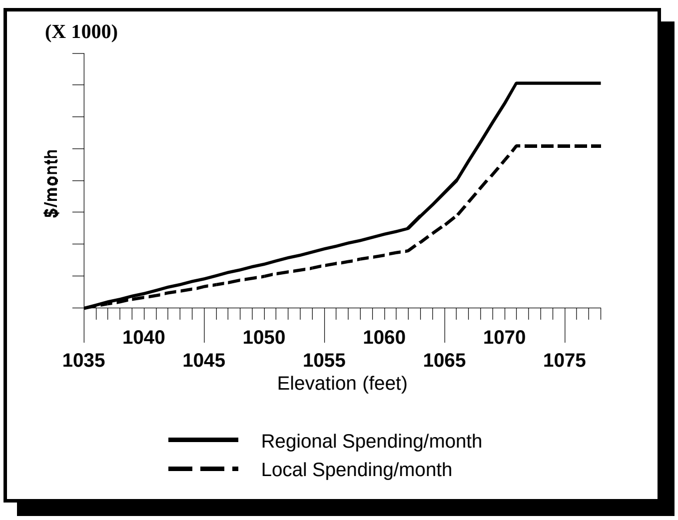

Figure 19 Regional Recreation Spending Format

Visitation/benefits/revenue curves will be developed for Lanier, West Point, Lake Harding/ Bartletts Ferry, Lake Oliver, Walter F. George, George Andrews, and Seminole, Carters Lake, Allatoona, the Etowah River between Allatoona and the Coosa, Weiss, Neely Henry, Logan Martin, Lay, Jordan, Harris, Martin (Tallapoosa), Yates/Thurlow, Bob Woodruff, Millers Ferry, Claiborne, and the Alabama River between Claiborne and the Tombigbee River.

Impacts to Agricultural Revenue. The Comprehensive Study partners asked the Natural Resources Conservation Service (NRCS) to estimate how gross revenues to farmers would be impacted by either long or short term curtailments in water provided for irrigation. In their report (Agricultural Water Demand, Appendix B-32, May 1996), the NRCS focused on three crops (corn, peanuts and soybean). The study estimated that, for the forecast year 2000, a complete cutoff of irrigation water for these three crops for one year would reduce farmers gross revenues by $203.5 million that year. If these restrictions were made permanent, farmers gross revenues would be reduced by about $140 million every year, assuming lower yields of the same crops because of the lack of irrigation. No attempt was made to predict how the change from irrigated production might alter crop selection or land use patterns (Appendix B-32).

Riverine Environmental Effects. A modified version of an integrated riverine habitat index called "Riverine Community Habitat Assessment and Restoration Concept" (RCHARC) is being developed for the ACT and ACF basins by the U.S. Fish and Wildlife Service, the Corps Waterways Experiment Station, and the National Biological Survey. RCHARC is a measure of the suitability of flows developed under future demands and alternative management rules for the current riverine populations. The index compares predicted flow to a "preferred" series of flows, and assigns an overall score of from zero (worst) to one (best). Some fishes prefer shallow water having low velocity, others may select deep, faster velocity areas, whereas the remainder of the community may prefer deep, slow water or shallow, fast water areas. Thus, the composition of the fish community will be determined by long-term patterns of depth and velocity frequency distributions, all other ecological factors being equal.

The year is divided into winter, spring, and fall and scores for each season are returned after each full (660 month) run of the model. The flows at Blountstown each month are exchanged from the STELLA II® portion of the shared vision model to the Excel® output portion of the model. The Excel software automatically calculates 5 flow rates for each run. These are flows that were exceeded 90, 75, 50, 75, and 10 percent of the time in a run. Examples of these flows are shown in **Table 15**. For example, a flow of 7813 cfs is low enough that 90% of the autumn flows produced in the STELLA II® run exceed it. The numerical rating of the similarity of the flow at each Exceedance level is assigned automatically in Excel according to tables prepared by the Fish and Wildlife Service. The scores for the different Exceedance levels are combined, using weighted coefficients for the flow profile in each season:

$$0.175 * Score_{90} + 0.2 * Score_{75} + 0.25 * Score_{50} + 0.2*Score_{25} + 0.175*Score_{10}$$

Table 15. Hypothetical example of seasonal scores for riverine suitability (Blountstown)

Exceedance Level	All	Winter	Spring	Autumn
0.90	11,881	16,000	16,000	7,813
0.75	19,508	19,508	16,000	13,000
0.50	31,177	31,177	17,446	13,000
0.25	45,100	45,100	26,771	16,404
0.10	54,746	54,746	39,033	22,631
Seasonal Score		0.1999	0.2109	0.1999

Similar values to those shown in **Table 15** will be calculated simultaneously for other stream reaches. The relative location of these reaches is shown in the Shared Vision Model schematics (**Figure 20** for the ACT and **Figure 21** for the ACF). These scores have no implicit meaning; an alternative with a score of 1 is not environmentally perfect, or twice as good as an alternative with a score of 0.5, but the riverine scores can be used to rank the alternatives in terms of their suitability for riverine life.

Wetland Environmental Effects. In general, riparian wetlands suffer when reservoirs regulate the higher flows that would otherwise create periodic inundation along river bank areas. In these basins, the only significant amounts of riparian wetlands are in the lower portion of the ACF. The Shared Vision Model allows users to rank alternatives according to how suitable the related flow regime is for the preservation of wetlands. This is done by the computation of a score which rates the similarity of flows for an alternative to flows prior to the construction of reservoirs (represented by the unimpaired flow data set). The similarity is weighted to give greater importance to high flows.

A wetland score is calculated at each of 12 sites in the ACT (**Figure 20**) and six sites in the ACF (**Figure 21**) for each 660 month simulation. The scores are calculated in a series of steps. First, the frequency at which the river rose above a series of elevations in the just completed run is calculated for each calendar month. For example, if the river was above elevation 50 for 66 of the 660 month simulation, the exceedance frequency would be 10%. These are compared to the exceedance frequencies of the unimpaired flows (the flows that would have occurred without reservoirs or consumptive use). A similarity score for each elevation and calendar month is calculated, defined as 1 minus the absolute value of the difference between the exceedance frequency of the modeled and unimpaired flows at that elevation divided by the exceedance frequency of the unimpaired flows. These monthly similarity scores are summed for 12 months, producing an annual similarity score at each elevation. The annual similarity score for each elevation is multiplied by the number of riparian acres covered at that elevation, and those totals are summed over all the elevations. Doing so means that similarities of flows at higher elevations is weighted more than similarity at lower elevations. The weighted similarity score for the modeled flows is normalized by dividing by a number representing a similar concept for the unimpaired flows (exceedance frequencies weighted by riparian acres covered). A perfect score is one, meaning the flows were identical to the unimpaired flows. A score of zero would mean that there was never any flow in the river at this site.

Reservoir fisheries. An effort under the Comprehensive Study to correlate “catch per unit of effort” to hydrologic variables led to the development of ideal reservoir condition profiles for the spawning and rearing of reservoir fish. The ideal condition for reservoir fish is for the reservoirs to remain stable or rise during the time the fish are growing. In the upper parts of these basins, the growing season lasts from late March to August, and in the southernmost areas, from February to November. A full reservoir is ideal for spawning, because it offers the greatest area under water. More important is that the level remains constant during spawning and rearing.

Current reservoir management practices generally run contrary to that ideal. In practice, the reservoirs are drawn down during this time, and reservoir temperatures increase with lowered levels and the inflows of water warmed in relatively shallow rivers. Three important complicating factors are that a specific annual reservoir management regime may not be optimal for all types of fish, since their seasons and needs do not exactly align; that deviations from the annual regime, such as winter drawdowns every 3 to 10 years, depending on the reservoir; and that what is good for reservoir species - lower flows between reservoirs - is generally bad for riverine species.

A scoring system similar to the wetlands and riverine systems is being developed by the NRCS and will be included in the final shared vision model.

E. Constraints

There are two minimum instream flow targets on the Chattahoochee River; 750 cfs at Peachtree Creek (under an agreement between the Mobile District and the State of Georgia), and 1,150 cfs at Columbus.

V. MEETING FUTURE NEEDS WITH THE CURRENT SYSTEM

The second of the three primary goals of the Comprehensive Study was to assess whether the future water needs of the basins could be met.

A. Defining a Reference Condition. The assessment requires a definition of both what the system is and what the future demands will be. Uncertainty about these assumptions and the sensitivity analyses that can be performed to determine the impact on system performance is discussed on page 48. All model runs use the so-called "unimpaired flows". These are the historic flows adjusted to eliminate the effects of reservoir regulation and consumptive use. In effect, these represent the flows that would have occurred in the last 55 years had there been no human development. In the Shared Vision Model, the unimpaired flows are regulated by user selected reservoir operating rules and depleted by user selected withdrawals and returns.

This reference condition is not the same concept as the "without project condition" established in Principles and Guidelines. That condition describes the current and future condition that is expected to occur if no action is taken as a result of the federal study. But the reference condition will probably not be sustained through the planning period.

It should be noted that the current Corps rules force the reservoirs to make releases to meet instream water quality and navigation flow targets until they are drawn down completely (although releases for navigation and hydropower are reduced as reservoirs drop). As consumptive demands increase, the rules in the reference condition would make releases for water quality and navigation larger and larger to make up for the depletions for consumptive use. Since this is in effect using Corps storage for consumptive demands, a reallocation study would be necessary at some point. By using the reference rules, the reallocation of storage occurs automatically. Although the reference condition does not represent the expected future, it is useful as a baseline against which to measure the performance of alternatives. The reference condition is also not a judicial ruling on how water must be allocated.

Table 16. Definition of the Reference Condition

- the reservoir operating rules in the Corps Water Control Plan and the current operating rules for privately owned reservoirs. As part of the process of building the shared vision models, engineers from the Corps and from the power companies worked with the University of Washington to assure that their written operating rules were correctly translated into the logic of the STELLA II® models.

- the relationship between surface and groundwater agreed to by the TCG.

- M&I forecasts that reflect the future impacts of current conservation measures.

- existing water interbasin and intercounty transfers.

- the middle forecast of agricultural water use.

- the single estimate of water needs for thermal power plants developed by the Power Resources Task Force.

- the middle estimate of tonnage from the navigation element.

- current minimum instream flow targets.

- in some areas, the use of groundwater depletes stream flows:

  a. 1 MGD of groundwater pumping reduces streamflows by 1 MGD in the month the water is pumped in the Georgia Piedmont region

  b. 1 MGD of groundwater pumping reduces streamflows by 0.31 MGD in Southwest Georgia, with 70% of the reduction in occurring the month of pumping, the rest in the following month

B. Aggregations of Consumptive Demands in the Shared Vision Models. The current and future withdrawals of surface water were aggregated into 22 reaches in the ACT (**Figure 20**). and 11 reaches in the ACF (**Figure 21**). Groundwater withdrawals reduce surface water flows in the Piedmont region and in South Georgia. Because of the controversy involving the exact effect of groundwater pumping on surface flows, the model allows the total effect and the timing of the effect to be varied in South Georgia.

The aggregations were made by the Working Group and the water use forecast teams. Planning and Management Consultants, Ltd. (PMCL) prepared a county by county water balance table that tracked M&I withdrawals from surface and ground sources, transfers both in and out of the basins and in and out of individual counties, and returns. PMCL and the University of Washington worked together to map the county to Shared Vision Model reach assignments, and created linked spreadsheets to duplicate these mappings for all forecast year and scenario options. The Natural Resource Conservation Service (NRCS) provided preliminary monthly water use forecasts for 25 subregions, and these data were re-arranged and implanted in the Shared Vision models by IWR and the University of Washington. The M&I and agricultural assignments were reviewed by the Basinwide Management Working Group. Options for interbasin transfers and the rerouting of returns were designed by Georgia EPD and the University of Washington. Supply sources for thermal process water were provided by the Power Resources Task Force.

C. Treatment of Groundwater in the Shared Vision Model. About 15% of M&I and about 65% of agricultural water is supplied by groundwater. The safe yields of the aquifers that supply these needs have not been calculated, but in general, where groundwater exists, it is bountiful. However, in many areas, groundwater pumping reduces the amount of water that flows from the aquifers into streams. The partners in the Comprehensive Study commissioned U.S.G.S. studies, including a numeric model of the interaction between the Floridan aquifer and the Flint and Apalachicola Rivers, to estimate that flow.

The default assumption in the Shared Vision Model is the same as was used in the development of the unimpaired flows. But Florida believes this algorithm is technically flawed and agreed to its use only for the development of unimpaired flows. Consequently, the partners asked that the Shared Vision Model include slider bars that allow users to determine the impact of different assumptions about ground-surface interaction on the performance of the basins. An example of that sort of sensitivity analysis is provided on page 48.

In the central ACT (Shared Vision Model reaches 4-10, 12, 14, and 15, **Figure 20**) and northern Chattahoochee basins (Shared Vision Model reaches 1-4, **Figure 21**) the shared vision model treats each 1 MGD of groundwater pumping as if it were a 1 MGD surface water withdrawal in the same reach and the same month. The default ratio can be continuously reduced to as little as 0 surface water flow reduction per 1 MGD of pumping (no effect) in order to determine the effects of this assumption on the performance of the basins.

Near the Floridan aquifer, for each 1 MGD of groundwater use associated with ACF reaches 8, 9, 10, and 11 (see **Figure 21**), 0.30 MGD of surface water is withdrawn. The 0.30 MGD is split 70% - 30% between the month the pumping occurs and the following month, with 63% of the water taken from ACF reach 7, 31% from reach 9, and 6% from reach 11. This replicates the adjustments made to historic flows for historic pumping in the development of unimpaired flows.

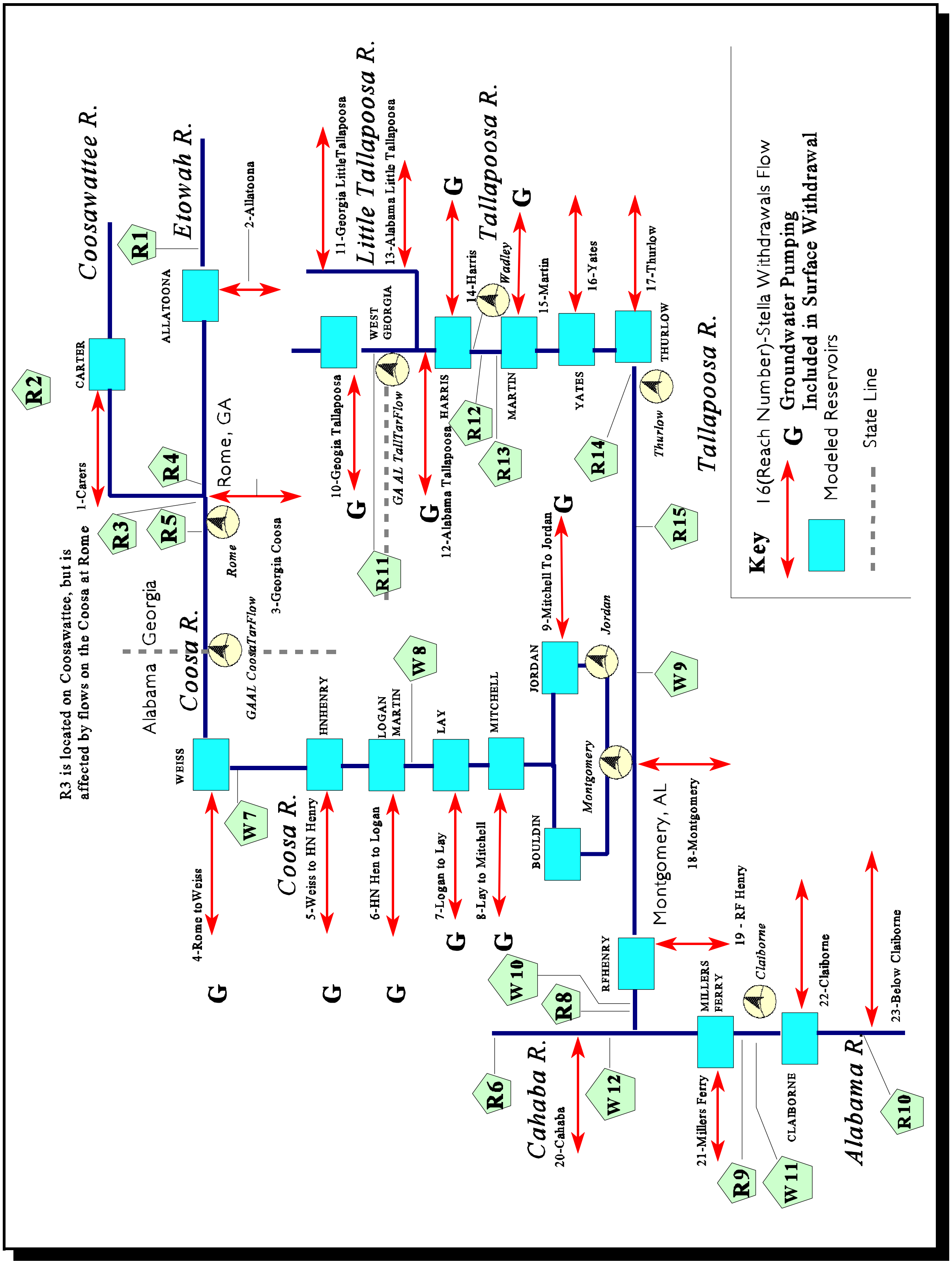

Figure 20. ACT Shared Vision Model Schematic

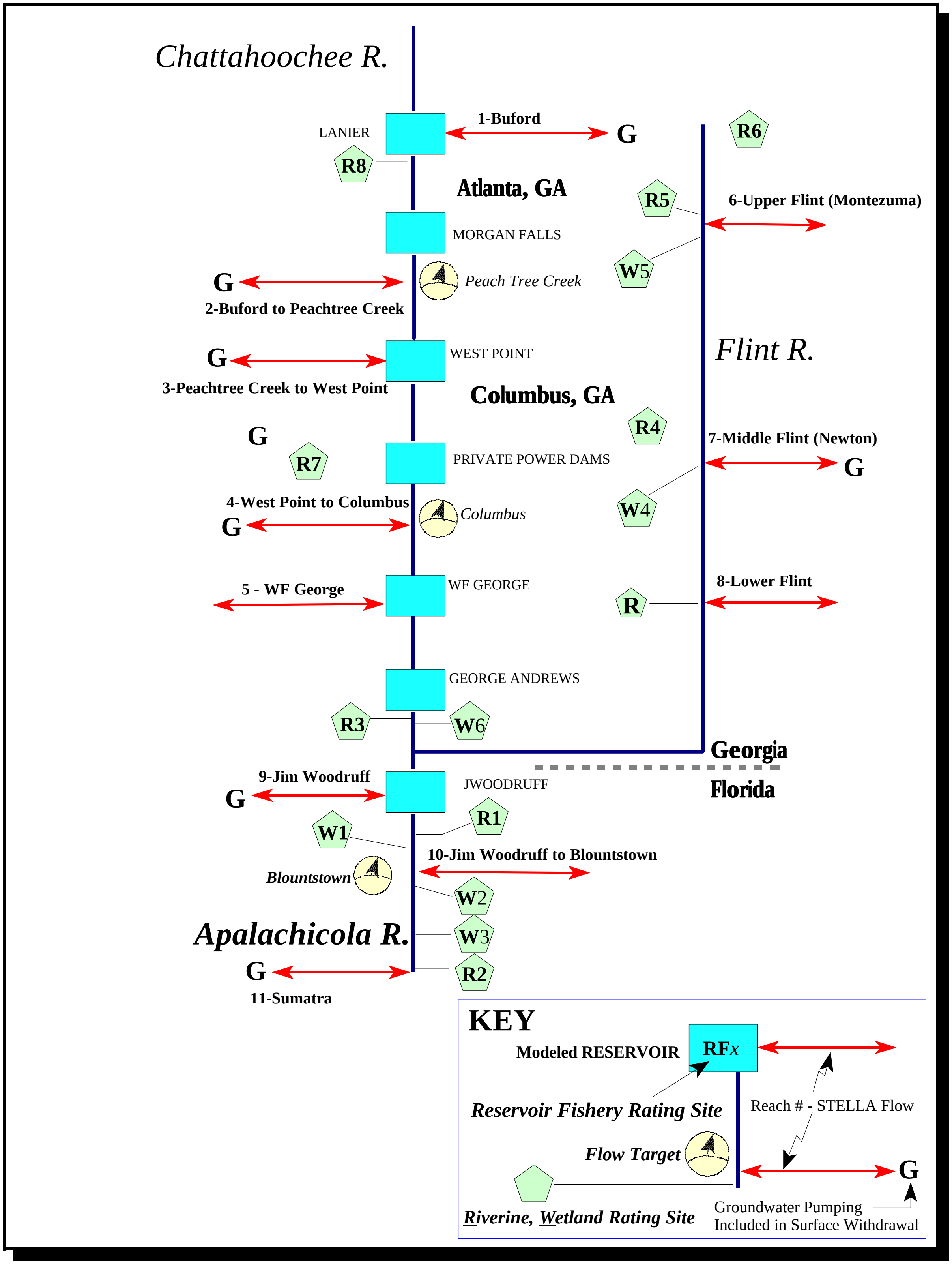

Figure 21. ACF Shared Vision Model Schematic

The linkage between pumping and surface flows means that most groundwater water use in these basins has some effect on surface water flows and the reliability of other uses. Overall, about 90% of all agricultural groundwater use and about 50% of M&I groundwater use in the two basins affect surface water flows in the Shared Vision Models. That leaves about 6% of agricultural demand and about 6% of M&I demand that is assumed to be satisfied by water in aquifers, without affecting surface water flows.

D. System Performance of the ACT and ACF Basins under Future Demands. **Table 17** and **Table 18** show how performance of these two basins changes over time under the assumptions in the reference condition. In sum, instream flows and consumptive demands do quite well, but reservoirs are drawn down further and more frequently. In both basins, there is nearly perfect reliability of consumptive demands as a result of the Corps reservoirs maintaining instream flows. Exceptions occur in ACT reaches without reservoir storage.

In the ACF (**Table 17**), the price for success in meeting consumptive and instream needs is often seen in the frequency and severity with which reservoirs are drawn down, and the reduction in flows into the Bay. The reliability of Lake Lanier elevations preferred for recreation (between 1065 and 1071) drops from 59% to 50%. During those "failure" periods, Lanier water levels average about 1059' with 1990 demands, about 1056 with 2050 demands. Recreation reliability at West Point and Walter F. George also drop by a few percentage points. Hydropower performance generally declines.

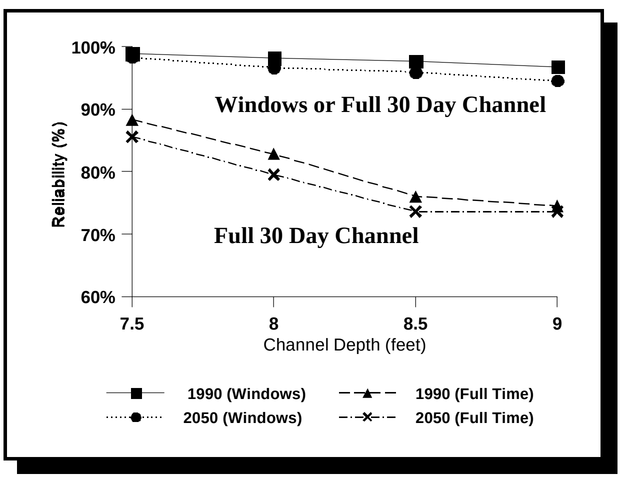

Figure 22. Reliability of ACF Navigation

The reliability of navigation on the ACF will drop by one to three percentage points in the next fifty years. Not counting the "windows" months in which the Corps concentrates releases to provide navigation for part of the month, the reliability of 9 foot channel depths will drop from about 74 to 72%. Using windows, however, nine feet of depth will be available 97% of the time with current demands, and over 94% of the time under 2050 demands.

Table 17. Performance in the ACF: Reference Condition, 1990 and 2050 Demands

	1990	2050
Consumptive Demands - All ACF Reaches		
Reliability	100	100
Water Quality Targets		
Peachtree Creek Reliability (%)	100	100
Columbus Reliability (%)	100	100
Flows at Blountstown - see Figure 24, page 46.		
Recreation		
Lanier Reliability (% of months within 5' of top)	58.9	50.2
Lanier Vulnerability (ft.)	6.4	8.1
Average Lanier Elevation	1065.4	1063.7
Minimum Lanier Elevation - see also **Figure 23**, page 46.	1044.2	1036.5
West Point (% of months within 3' of top)	74.2	70.7
West Point Vulnerability (ft)	3.6	3.5
WF George (% of months within 3' of top)	87.6	87.6
WF George Vulnerability (ft)	1.1	1.1
Navigation - see also		
Reliability, 7½ ft channel	88.6	85.6
Vulnerability @ 7½ ft (cfs)	1,969	2,291
Reliability, 9 ft channel	73.9	72.1
Vulnerability @ 9 ft (cfs)	3,333	3,749
Hydropower		
Buford Reliability @ 8,400 MWH per month (%)	49.6	43.3
West Point Reliability @ 6,557 MWH per month (%)	91.1	90.6
WFGeorge Reliability @ 7,895 MWH per month (%)	100	100

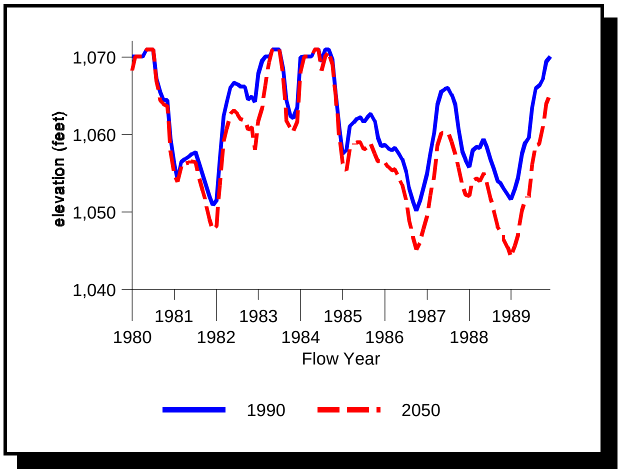

Figure 23. Lanier Elevations 1990 and 2050

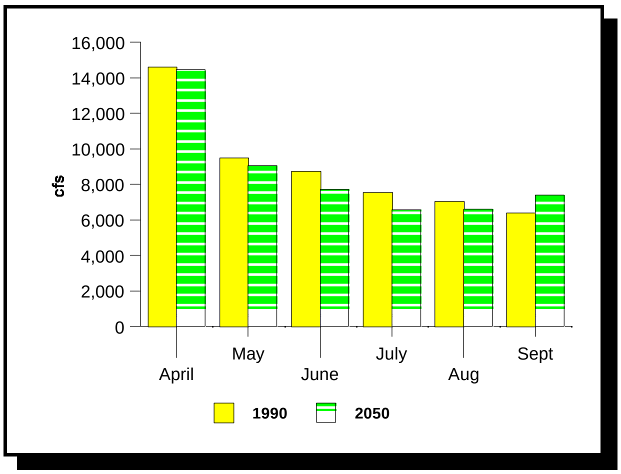

Figure 24. Minimum Flows at Blountstown

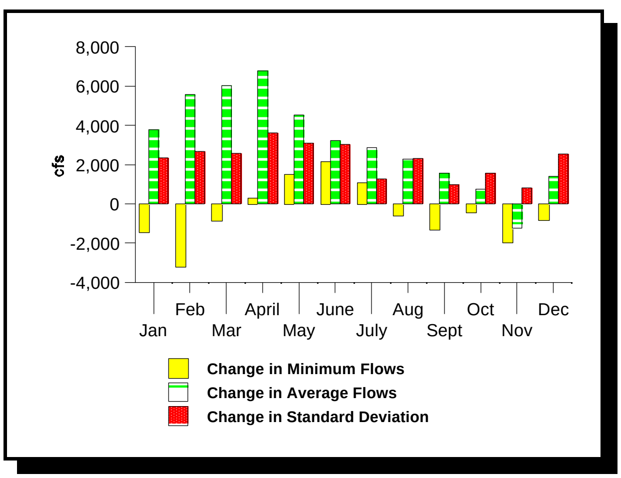

Figure 25. Historic and 2050 Flows at Blountstown

Lanier lake levels fluctuate more dramatically than other lakes in these basins because its releases are based on its storage, the largest in the system, but its refill is slowed by low inflows. **Figure 23** is based on just the inflows of the 1980's (for viewing clarity), and the demands of 1990 and 2050. The minimum level at Lanier for the entire 660 month run is 1044.2 feet with 1990 demands, 1036.5 feet with 2050 demands.

Minimum flows at Blountstown for April through September are shown in **Figure 24**. The reductions in minimum flows from 1990 to 2050 are the result of all the net consumptive demand increases above Blountstown, including groundwater pumping depletions of surface flows. These depletions are calculated in the Shared Vision Model according to the relationship between pumping and surface flows used to develop the historic flow data. An evaluation of the sensitivity of these flows to assumptions about future agricultural use and groundwater to surface water effects can be found on page 48. **Figure 25**, **Figure 39** shows how minimum and average flows, and the standard deviation of flows change comparing the Reference Condition, 2050 demands, and historic flows at the Blountstown gage. Negative numbers indicate that the reference condition numbers are lower.

Table 18. Performance in the ACT, Reference Condition, 1990 and 2050 Demands

	1900	2050
Consumptive Demands - Reliability		
Reliability - All But Reaches 11, 13, and 20 (%)	100	100
Reach 10	100	99.39
Reach 11	99.85	99.85
Reach 13	99.85	99.85
Reach 20	100	98.79
Alabama State Line Flows		
Coosa Reliability	100	100
Coosa Minimum Flow (cfs)	1.274	1,200
Recreation		
Carters Reliability (% of time within 3' of top)	100	100
Allatoona Reliability (% of months within 3' of top)	96.5	96.4
Allatoona Vulnerability (ft)	4.5	4.7
Weiss Reliability (% of months within 3' of top)	99.1	99.1
Weiss Vulnerability (ft)	0.8	1.2
Lake Martin Reliability (% of months within 3' of top)	99.2	99.1
Lake Martin Vulnerability (ft)	2.8	2.8
Navigation		
Reliability of 7 ½' channel (%)	88.9	87.3
Vulnerability @ 7 ½' (cfs)	1,658	1,778
Reliability of 9' channel (%)	84.5	82.4
Vulnerability @ 9' (cfs)	2,052	2,166
Hydropower-Average Hours Generation		
Allatoona	7.37	7.22
Carters	2.05	2.05
Harris	4.51	4.42
Weiss	11.11	10.97

The answer to the question, “Will there be enough water?” is a little different for the ACT compared to the ACF. First, there are four reaches which do not have perfect reliability for consumptive use. These four are on unregulated streams, and cannot rely on stored water to meet agricultural and M&I demands during low flow periods. Second, there is no ACT reservoir with the slow refill time and low recreational reliability of Lake Lanier. Recreational reliability declines slightly at Allatoona and Martin, but even with 2050 demands, the levels undesirably low for only about 6 of the 660 months in the simulation. Recreational vulnerability - the average depth below the desirable level during those few months - varies from 1 to 2.8 feet on these reservoirs, compared to almost nine feet over about 330 months at Lanier. Third, the reliability of the ACT navigation channel is about the same as the ACF at 7½ feet, but is much better at 9 feet. Finally, peak energy production at Allatoona, Harris, and Weiss declines slightly as more of those releases are used to meet consumptive demands.

E. Sensitivity Analysis. There is some degree of uncertainty about all the factors used to forecast the future reliability of these systems. The Shared Vision Model helps address uncertainty by allowing users to vary the data and relationships they are uncertain of, while monitoring the effect of those changes on the model's estimate of system performance. **Table 19** shows some of the options the Shared Vision Model user can select to investigate how errors in underlying assumptions would affect the conclusions drawn from the model runs. A complete list of the control options available in the Shared vision Model is included in the Appendix to this report, starting on page 83.

Table 19. Variables for Sensitivity Analysis

Growth
1. Nav and ag medium
2. Nav and ag high
3. Nav and ag low
4. Nav high, ag medium
5. Nav high, ag low
6. Nav low, ag high
7. Nav low, ag medium
8. Nav medium, ag high
9. Nav medium, ag low

Effect of Pumping on Surface Flow
This can be adjusted in ACT reaches 4-10, 12, 14, and 15, and ACF 1-4, 7, 9, and 11. See page 41 for details.

Return rate from Agricultural Use
1. Default is 0%, user can vary.

Slider Bar Adjustments for Forecasts
1. User can vary universally or by reach for M&I or agriculture or thermal or any combination.

Daily Flow Correction Factor
1. Default is 1

Table 20. An Example of a Sensitivity Analysis, ACF

Measure of Performance	Reference Condition Expected 2050 Demands 30% Groundwater Factor, Over 2 Months	Reference Condition High 2050 Ag Demands 61% Groundwater Factor, Over 1 Month
Lanier Recreation Reliability (%)	50.2	47.8
West Point Recreation Reliability (%)	70.7	69.4
Navigation Reliability @ 7½ ft (%)	85.6	85.1
Navigation Reliability @ 9 ft (%)	72.1	70.0
Buford Energy Reliability (%)	43.3	42.3
West Point Energy Reliability (%)	90.6	90.3
W.F.George Energy Reliability (%)	100.0	100.0

Example. Two 660 month simulations of the ACF were run. Run 1 used the reference condition with expected agricultural demands and the groundwater pumping - surface flows relationship used to create the historic flow data set. The results of this run were summarized under the "2050" column in **Table 17**.

A second run was made with changed assumptions in three areas where there is uncertainty about the data used. First, the high forecast of 2050 agricultural use replaced the expected 2050 forecast. Second, each 1 MGD of groundwater pumped from the Floridan aquifer was assumed to reduce surface flows by 0.606 MGD (rather than 0.303 MGD), and third, the reduction in surface flows was assumed to occur in the month of pumping, rather than lagged over two months.

Table 20 shows that the reliability of lake recreation, navigation, and energy production estimated in Run 2 is less than estimated in Run 1. **Figure 26** shows the decline in average and minimum monthly flows at Blountstown from Run 1 to Run 2. The differences in summer flows approaches 1,000 cfs, or more than 600 MGD. To put this in perspective, this is equivalent to the total *net use* (withdrawals minus returns) for M&I for the entire ACF Basin.

Further analysis shows that the pattern of flows is also changed because of varying proportions of unregulated Flint flows in the Blountstown reading and because of the way the current operating rules respond to the need for supplemental navigation releases and. Flows are similar in both runs except in the growing season, when agricultural pumping is significant. **Table 21** shows the amounts of groundwater pumping in each calendar month for agriculture in the high 2050 forecast. Flows are very different during the growing season, although not uniformly so. When flows are higher than the required flows for a nine foot navigation depth, the difference

Table 21. Subarea 4 Agricultural Water Pumping, High 2050 Forecast

Month	Pumping (**MGD**)
January	3
February	4
March	9
April	104
May	712
June	1,876
July	1,276
August	662
September	45
October	32
November	16
December	4

between the two runs is the full amount of the depletions from higher use and higher groundwater effect.

But when flows at Blountstown are lower and the reservoirs are full, then the flows are the same in both runs, because the reservoirs release enough water to provide navigation depths. Finally, when flows and reservoirs are low, the amount of supplementation is reduced, so there is an appreciable difference between the flows again.

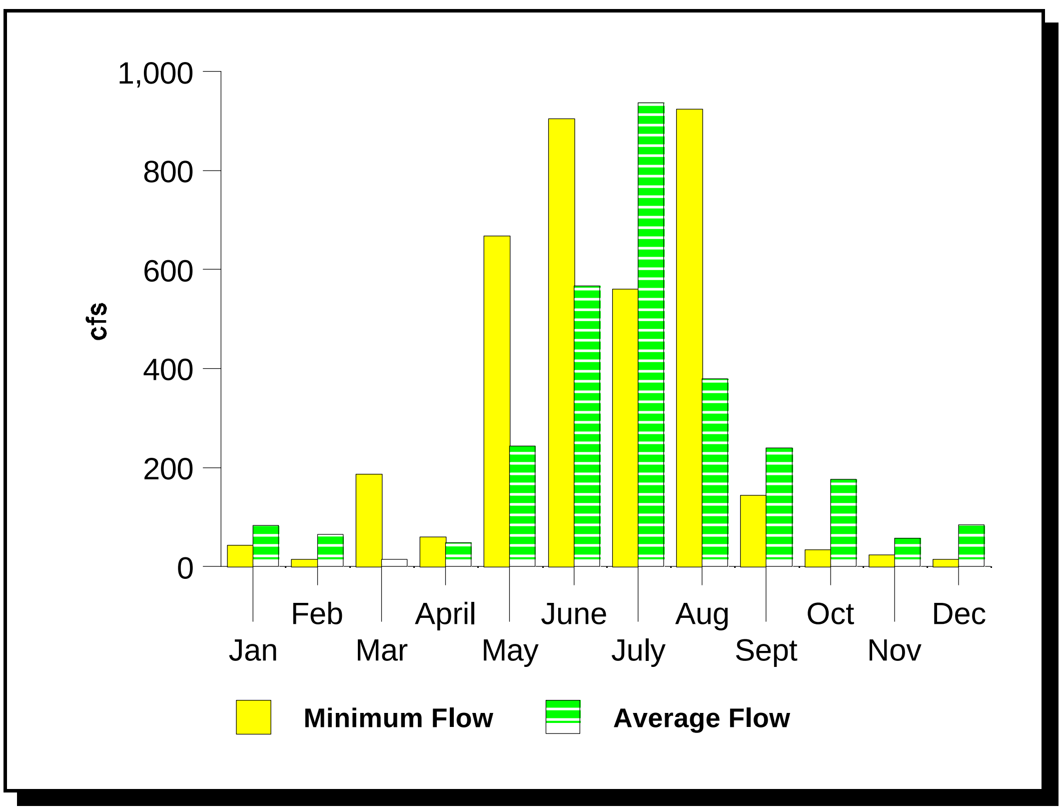

Figure 26. Declines in Blountstown Minimum and Average Flows

VI. MODELING BASINWIDE ALTERNATIVES IN THE SVM

A. Formulation Principles. The formulation and evaluation of alternatives will be driven by several factors:

- a desire to resolve the conflicts that led to the lawsuit;
- the belief that basinwide management would begin, not end in the Comprehensive Study;
- a desire by the study partners to make the process open to stakeholders;
- caution about evaluations based on draft or partial data;
- the desire to use the basinwide models in the development of interstate agreements, drought contingency plans, and future project feasibility studies.

The formulation of alternatives continues as this draft is printed. The alternatives presented in this report include those specifically proposed by Georgia, Mobile and Florida and those developed by the University of Washington to capture alternative concepts proposed by Alabama and to address the partners' management objectives.

B. Stakeholder Ideas. At their first workshop, the Basinwide Management Task Force generated a list of alternatives that they wanted to see addressed in the Basinwide Study (**Table 22**). The TCG also asked for alternatives to be developed by study contractors (**Table 23**). The draft model can formulate almost all the Task Force alternatives except those for which necessary data has not been collected.

Table 22. Status: Ability of the Draft SVM to simulate Task Force Alternatives

Alternative	Model Capability
Periodic flooding of the flood plain forests	Can determine effects on water supply
Guarantee "historic" (pre-dams) water flow to Apalachicola Bay.	Can simulate now
Close Sikes Cut in Apalachicola Bay.	Cannot simulate - will be evaluated using the Apalachicola Bay model (see page 13)
Impose a minimum 90% return on all water removed from the basin	Can simulate now
BMP's for agricultural water use, and change crops grown to lower water use	Ag Scenario 3 represents expert opinion on the amount of water that could be saved through conservation
Increase thermal reserve areas for fishes.	There is no information that could be used to assess thermal reserve areas
Continual navigation windows	Model can simulate now
Allowance for increased irrigation usage	Model can simulate now
Conservation for all applicable purposes	Model includes results of M&I, ag conservation. No studies have been done for thermal conservation, but the model can simulate the effects of lower use.
Control plan for power generation.	Model allows great control
Seasonal drawdown of Allatoona	Model can simulate now
Carefully consider all return flows to the systems, particularly in the Atlanta area.	Return flows tracked carefully (see page 40, **Table 16**)
Determine development compatible with environmental capacity of streams	That level has not been defined in the environmental studies
Minimum flow below Woodruff	Model can simulate now
Create an ACF-ACT link	Basins can be linked now.
Fixed flows in reaches determining stocks	Target flows can be set in many reaches.
Dependable capacity hydropower operation of all federal reservoirs.	Model can simulate now
Reduced seasonal flood-control drawdown of West Point, Allatoona	Model can simulate now
Reduced winter drawdown of Allatoona	Model can simulate now.

Table 23. Components of Alternatives Formulated Outside the Basinwide Study

1	West Georgia Reservoir (Tallapoosa River)
2	M&I Conservation from higher water prices, rebate programs, residential and commercial water audits.
3	Agricultural conservation from the use of different irrigation and harvesting equipment, irrigation scheduling, and water reuse.
4	Extension of Coosa navigation from Montgomery to Gadsden.
5	Extension of Coosa navigation from Gadsden to Rome.
6	Construction of a Chipola cutoff weir, and dike fields, and use additional dredging on the **ACF** to provide full Navigation depth at 9,300 cfs.
7	Construction of a Chipola cutoff weir, and dike fields, and use additional dredging on the **ACF** to provide full Navigation depth at 11,000 cfs.
8	Construction of dike fields, and use additional dredging on the **ACF** to provide full Navigation depth at 9,300 cfs.
9	Construction of dike fields, and use additional dredging on the **ACF** to provide full Navigation depth at 11,000 cfs.
10	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACF** at 11,000 cfs.
11	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACF** at 13,000 cfs.
12	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACT** at 5,000 cfs.
13	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACT** at 6,600 cfs.
14	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACT** at 7,500 t.s.
15	Construction of dike fields and use additional dredging to provide full navigation depth on the **ACT** at 9,500 cfs.

C. Defining on Alternative. Any change in the way water is managed is an alternative. The components that can be assembled into an alternative are described in the next few pages. Alternatives can be formulated by varying reservoir operating rules, flow targets, demand management, or by building or modifying water management structures. These controls provide the alternative formulation capability of the shared vision models; a user can change almost any part of the water management system and see how performance is affected.

A description of each of the components (e.g., West Georgia Reservoir) or types of components (e.g., raise the bottom of the conservation pool in a reservoir) follows.

Zone or rule curve operation. Reservoirs are typically divided into three vertical layers. Reservoir designers set aside the lowest level as dead storage because they know that over decades this area will fill with sediment. The top layer is used to store the occasional high inflows that would otherwise cause floods. The middle level is used for water supply and instream flow requirements, and is often called the conservation pool. In rule curve operation, managers try to keep water at the top of the conservation pool (the "curve") except as necessary to meet downstream needs or to temporarily store high inflows. This elevation may change from month to month, being lower in the flooding season.

Zones divide the conservation pool into smaller vertical layers; releases are reduced when the water level drops into the lower zones. Zone elevations typically change through the year to accommodate the fact that there is less inflow and greater demand for water in the summer. The Corps Water Control Plan uses zones which reduce the number of hours of peaking releases for hydropower and the support for navigation when water levels drop.

Changing the top of conservation pool. The top of conservation pool in a Corps reservoir is the elevation at which the reservoir is considered "full" in a given month for water supply purposes. Space above that level is reserved to retain flood waters. No one knows exactly how much of the flood storage of these reservoirs could be converted to conservation storage. Determining that would require surveys of the current level of floodplain development and studies to determine how often and to what depth the floodplain would be inundated with smaller amounts of flood storage capacity. What can be determined with this model is whether converting some flood storage to conservation storage makes enough difference in the reliability of water supply to warrant a flood damage study.

Raising the Bottom of Conservation Pool. Releases can be made from any elevation above the bottom of the conservation pool; storage beneath the conservation pool is reserved for the accumulation of sediment. Complete drawdowns are rare and surprisingly deep. For example, Lake Lanier would drop about 35 feet if it were drawn down to the bottom of its conservation pool. Raising the bottom of the conservation pool reduces water supply yield but keeps lake levels higher for recreation.

Minimum continuous releases. Some reservoirs help support minimum instream flow requirements on a 24 hour basis, but those requirements are also supported by inflows below the reservoir and the peaking releases during the middle of the day. A continuous minimum release is used in non-peaking hours to support the target. Reducing this release keeps reservoirs higher; the effect on how well instream targets are met can be measured in the model.

Peaking Hours. The peak demand for electrical power occurs in the middle of the day; hydropower is used primarily during this time because it is so well suited to short cycle production. Reservoir releases during peaking hours are usually much higher than in non-peak hours, so reducing the number of peaking hours generally keeps reservoir levels higher. Because power production is proportional to both release flows and reservoir elevation, having too few or too many peaking hours can reduce the value of hydropower at a reservoir.

Navigation/system support. Navigation is supported by a system of reservoirs. If natural flows are not sufficient to support navigation in the Apalachicola River below Jim Woodruff Lock & Dam, for example, releases are made from Lanier, West Point and Walter F. George to supplement the natural flows. The Shared Vision Models allow this system support to be turned off at each reservoir, which tends to keep that reservoir higher, while generally reducing navigation reliability.

Navigation Windows. As discussed on page 17, the Corps currently uses a practice called windows to increase the number of months the navigation channel is available, albeit for only a portion of the month. The Shared Vision Model allows the user to turn windows on all the time or off, or to specify the conditions under which a window is used in a given month. The model also allows the user to vary the number of days in a window for each of the 12 calendar months.

Flint River Storage. The Flint is relatively unregulated; it has a few, small run of river reservoirs. The Shared Vision Models can include the effects of a reservoir added to the Flint, using yield and flow statistics developed apart from the basinwide study.

West Georgia Reservoir. This is a proposal under development by Georgia; several combinations of sites, size, and operating rules have been proposed. The Shared Vision Model is configured so that a user can add a West Georgia Reservoir on the Tallapoosa River with a variety of specifications. Information on the physical properties such a reservoir would exhibit is taken from *Technical Memorandum No. 9,* a summary of technical studies prepared by CH2M Hill for Georgia Department of Natural Resources.

Water Quality Flow Targets can be changed. Increasing the targets increases minimum flows but depletes reservoirs. The two principal flow targets on the Chattahoochee River are at Peachtree Creek (750 cfs) and Columbus (1,150 cfs). These are the minimum flows required to dilute wastewater effluents.

Extension of the ACT Navigation Channel to Montgomery or Rome. No design costs or benefits were available for these alternatives at the time of this draft. Extension of the ACT navigation project will not materially change the water required for any purposes, since dams exist where the additional locks would be built.

Structural Modifications to Unregulated Sections of the Navigation Channels. A series of modifications to both existing channels was investigated to determine the costs of reducing the amount of water needed to provide enough depth for shipping. Four alternatives were designed and costed for the ACT, six for the ACF. The alternatives involved additional one time dredging and the use of dikes to reduce the need for maintenance dredging.

Dikes are used to train the low water channel into a smaller cross section with faster flows. If that can be done, the channel helps maintain itself by carrying sediment downstream to an off-channel area. Dikes were positioned where shoaling is persistent, and included four basic types:

> **Spur dikes.** These are connected to the bank at right angles to the flow. Most of the dikes were of this type. Upstream dikes are generally higher than downstream dikes. On the **ACT**, very low dikes (1 foot) were used without much success in the Alabama River in the 1970's, but dikes 5-10 feet above the low water dredging reference profile built between 1988 and 1992 have been very effective in some locations. Lengths of the spur dikes in these alternatives vary depending on the contraction intended, and are based on the width of the river where shoaling does not occur now. For a 7,500 cfs flow, sedimentation does not occur if the channel is more than 350-400 foot wide. For a 5,000 cfs flow, a 275 foot wide channel is required to eliminate sedimentation. On the **ACF**, dikes were built from 1 to 8 feet above the present dredging reference profile on the Apalachicola River in the 1960's, and were reasonably effective, and the designs for these alternatives use heights consistent with the 1960's dikes. Lengths of ACF spur dikes also varied depending on design flow. For a 9,300 cfs flow, the Apalachicola River above the Chipola Cutoff generally does not require dredging where it is 350-400 feet wide. A 415 foot wide and 490 foot channel were used as the zero dredging reference for the 11,000 cfs and 13,000 cfs dikes, respectively.
>
> **Longitudinal or L-head dikes**. The bottom of the “L” is positioned in the river pointing downstream. These dikes are placed where tributaries join the channel to move sediment down past the juncture of the two flows. L-head dikes are also placed at the end of spur dikes to extend the contraction.

Submerged vane dikes - not generally connected to the bank, these tend to widen the river in bends.

Prior studies indicate that after dikes were built on the Apalachicola River during the 1960's, dredging was reduced to about 45% of what it had been. Preliminary studies on the 1988-92 Alabama River dikes, of a newer design, show that it is reasonable to expect dredging to be reduced below 40% of pre-dike levels. Maintenance dredging would still be required where no dikes are placed. On the Apalachicola, the same 40% assumption was used, except for the Blountstown reach, where the efficiency of the dike design should eliminate the need for all but 10% of the dredging. Data evaluated by Mobile for the Comprehensive Study shows that the amount of water leaving the main (navigation) channel of the Apalachicola and going into the Chipola Cutoff has increased from about 22% in 1977 to 26% in 1989 to 31% of the total flow now. A split of 30%-70% was assumed for the "without weir" alternatives. Weirs were designed to restore the pre 1977 split of 22%-78%. **Figure 27** compares the flows required for a 9 foot deep channel in the Apalachicola for the reference condition and two structural alternatives.

On the **ACT**, only the 5,000 cfs alternative required an additional upland disposal site. On the **ACF**, no additional upland disposal sites were required for any alternatives, but the 9,300 cfs and 11,000 cfs alternatives required the use of some additional within bank areas at Cooley slough.

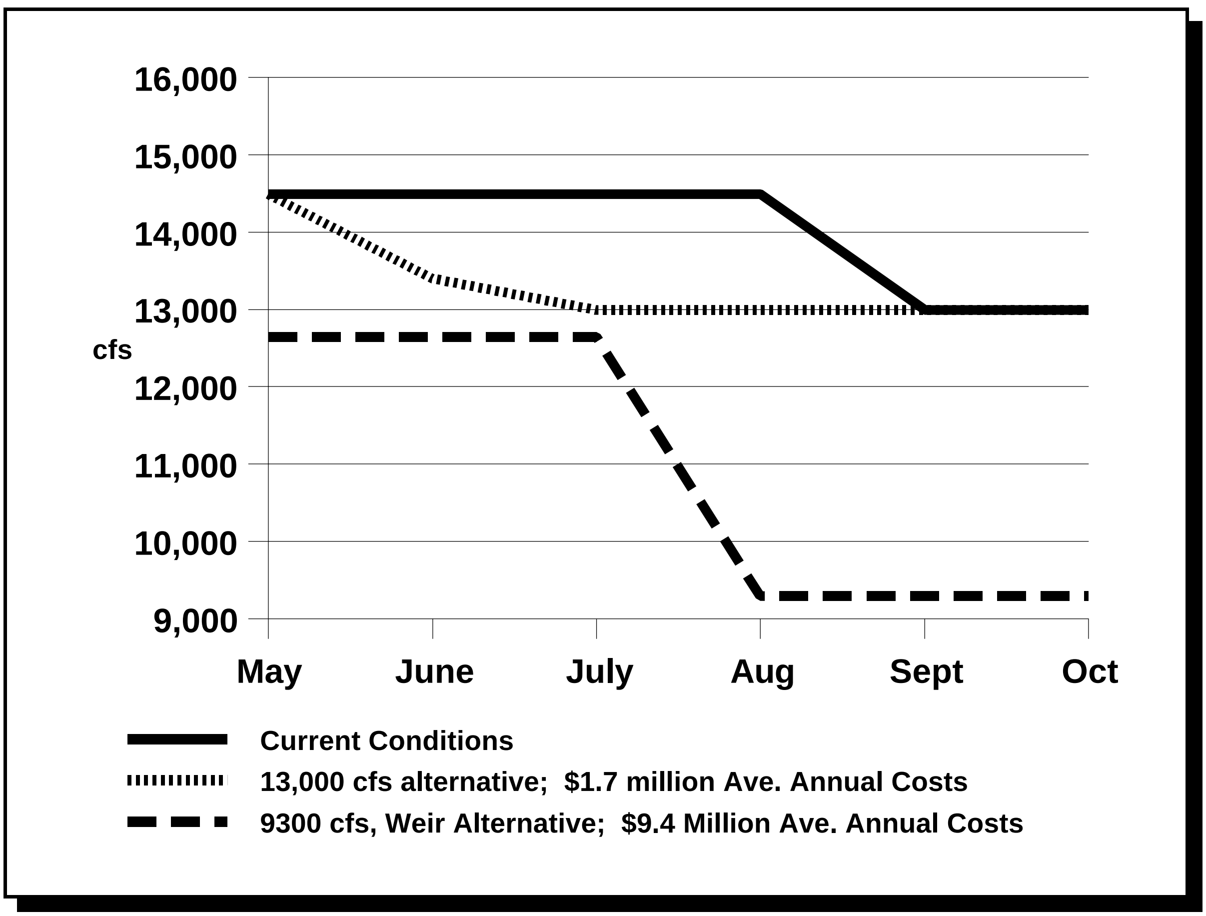

Figure 27. Flows Required for a 9 foot deep ACF channel currently and under 2 alternatives.

Table 24. ACF Structural Navigation Modifications to the Existing Project

Alternative	Features	Initial Excavation (cubic yards)	Average Annual Costs[1] ($ millions)
9,300 cfs with Chipola Weir	146 spur dikes, 56 vane dikes, 25 rehabilitated dikes, and 2 rock dams in Brown Lake tributary	946,897	9.361
9,300 cfs, no Chipola Weir	145 spur dikes, 56 vane dikes, 25 rehabilitated dikes, and 2 rock dams in Brown Lake tributary	1,120,542	9.408[2]
11,000 cfs with Chipola Weir	105 spur dikes, 34 vane dikes, 12 rehabilitated dikes, and 2 rock dams in Brown Lake tributary	519,609	5.025
11,000 cfs, no Chipola Weir	104 spur dikes, 34 vane dikes, 12 rehabilitated dikes, and 2 rock dams in Brown Lake tributary	541,087	4.977[3]
13,000 cfs, no Chipola Weir	37 spur dikes, 16 vane dikes, 9 rehabilitated dikes, and 2 rock dams in Brown Lake tributary	235,198	1.713[4]

1 - (based on a 50 year economic life, 7-5/8% discount rate)
2 - $14.318 million if flows into the Chipola Cutoff increase to 50%
3 - $9.907 million if flows into the Chipola Cutoff increase to 50%
4 - $3.263 million if flows into the Chipola Cutoff increase to 50%

Design channel width is 200 feet for the ACT, and 100 feet for the ACF, both the current widths. Keeping the width of the ACF at 100 feet made it possible to make consistent comparisons between the current and proposed channels, but the Corps recommended minimum width for a 70 foot tow is 125 feet.

Table 25. ACT Structural Navigation Modifications to the Existing Project

Alternative	Dikes	Initial Excavation (cubic yards)	Average Annual Costs[1] ($ millions)
5,000 cfs	157 spur dikes, 105 vane dikes, 5 L-Head Dikes, and rehabilitation of 28 existing dikes	2,334,160	7.387
6,600 cfs	111 spur dikes, 38 vane dikes, 6 L-Head dikes, and rehabilitation of 27 existing dikes	1,086,977	3.533
7,500 cfs	69 spur dikes, 29 vane dikes, 4 L-Head dikes, and rehabilitation of 28 existing dikes	669,841	2.071
9,500 cfs	24 spur dikes, 12 vane dikes, 2 L-Head dikes, and rehabilitation of 15 existing dikes	197,668	0.901

1 - (based on a 50 year economic life, 7-5/8% discount rate)

ACF Alternative Flow Patterns . These figures show the flows that would be required for 7½ to 9 foot depths in the ACF navigation channel under the alternatives. Less flow is needed after dredging in the spring, but sedimentation through the year increases flow requirements by year's end. Note that of the two 9,300 cfs alternatives, the one with a weir at the Chipola cutoff can sustain 9 foot depths at 9,300 cfs for a greater portion of the year. The alternative flows in **Figure 30** are slightly less for intermediate depths than the flows shown in **Figure 31**. Each graph shows flows for 7½, 8, 8½, and 9 feet. deep channels.

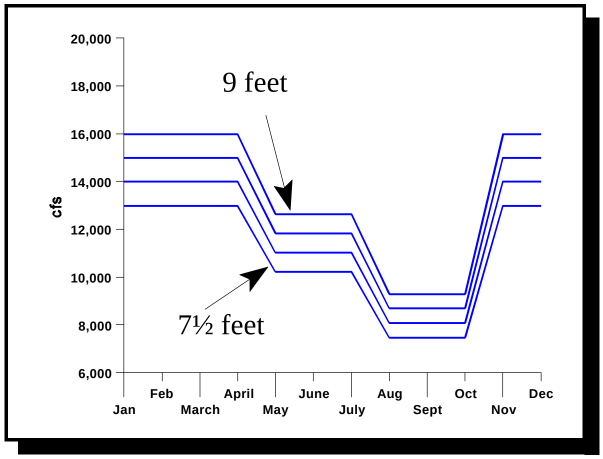

Figure 28. ACF, 9300 cfs with Chipola Weir

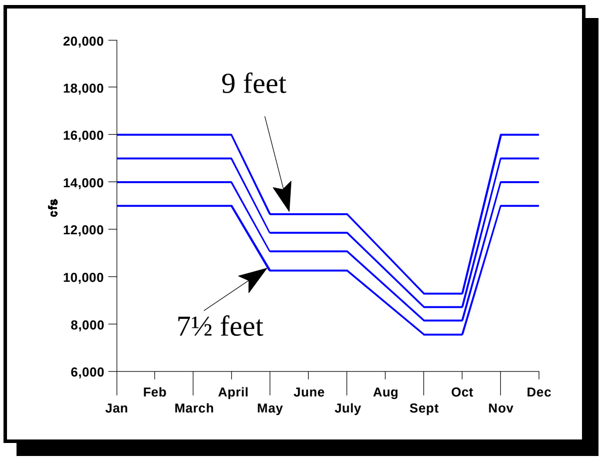

Figure 29. ACF - No Weir 9300 cfs

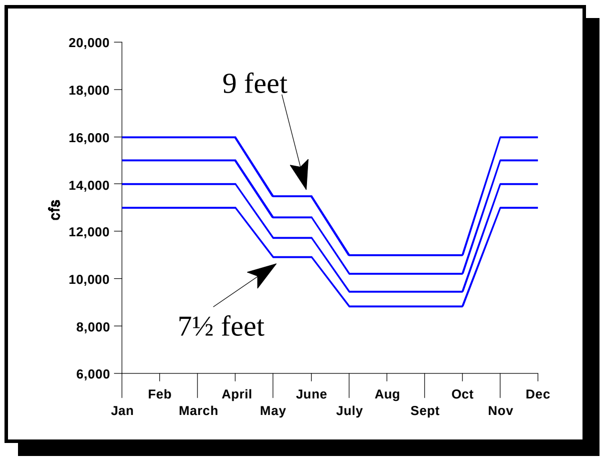

Figure 30. ACF-Chipola Weir 11000 cfs

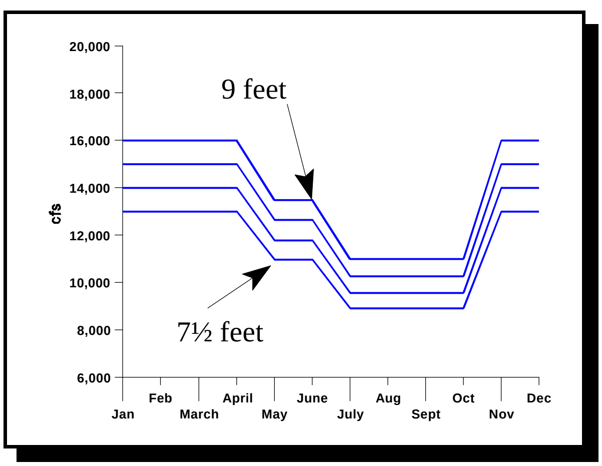

Figure 31 ACF - No Weir 11000 cfs

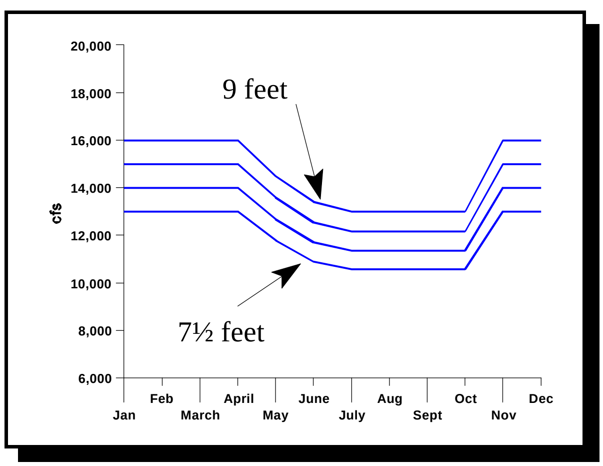

Figure 32 ACF - No Weir 13000 cfs

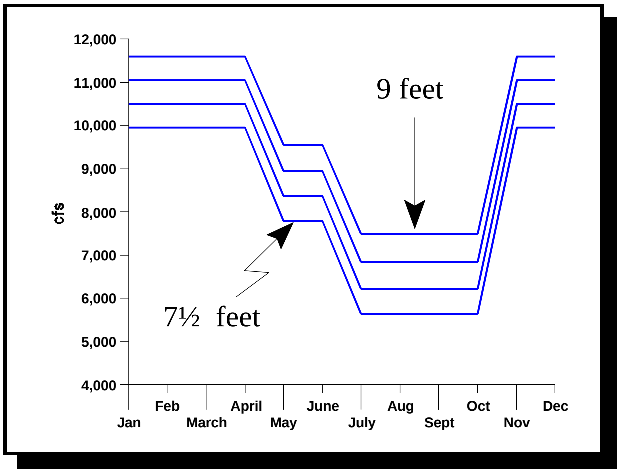

Figure 33. ACT - 7500 cfs Alternative

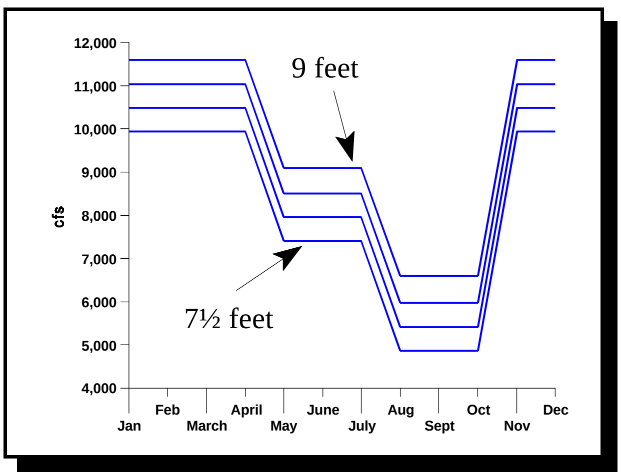

Figure 34. ACT - 6600 cfs Alternative

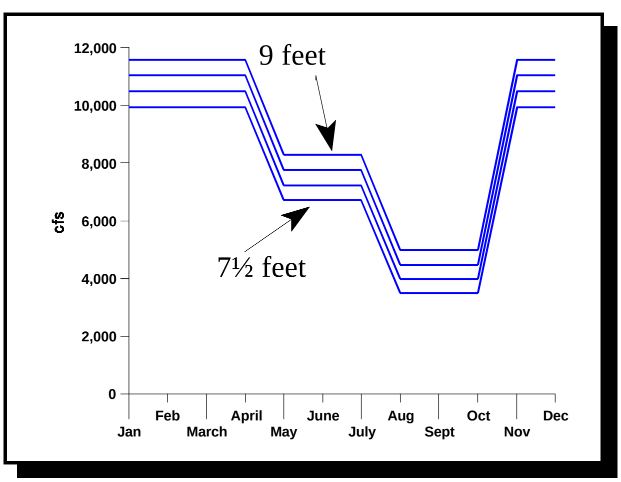

Figure 35.ACT - 5000 cfs Alternative

ACT Alternative Flow Patterns. These figures show the monthly flows required in the Alabama River for each of three ACT alternatives. Each figure shows the flows for 7½, 8, 8½, and 9 feet of depth.

M&I Conservation

The estimates of future water municipal and industrial water use were made based on the expected effects of water conservation measures, such as the national manufacturing standards for new plumbing fixtures, that are already in place. However an additional set of M&I water use estimates were made based on the assumption that more aggressive water conservation measures used in portions of the study area would be implemented throughout the study area. The implementation of these measures is a demand management alternative; its components and water use savings are described below.

Components of the M&I Conservation Plan. This alternative is a *long term* conservation measure; even more stringent conservation methods, such as a ban on lawn watering, might be imposed temporarily during severe droughts. Each of the components of this alternative are already being used somewhere in the study area; this alternative simply applies these measures in every county in the study area. This alternative consists of:

a. a one time increase in water and wastewater prices throughout the study area at the start of the planning period. Summer marginal prices were increased 12.7%, winter marginal prices were increased 13.1%, and the summer and winter fixed charges were increased 6.7% and 8.1%, respectively. These price increases are the average increases from 1990 to 1994 of those 50 counties that did increase prices. The one time price increases are put into effect for the 1995 and later forecasts.

b. a residential rebate program from 2000 to 2004 to encourage homeowners to replace working 3.5 or 5 gallon per flush toilets with new, 1.6 gallon per flush toilets. This hastens the water savings that would normally materialize when the older toilets failed and had to be replaced. Typical rebate programs provide cash rebates to purchase and install a water saving toilet. Experience shows that about 25% of eligible households will participate.

c. a residential indoor/outdoor home water audit and retrofit program from 2000 to 2009. Under such programs, experts make home visits to check for leaks, install faucet aerators and low flow showerheads, replace toilet flap valves and adjust the fill valve if needed, and review outdoor water use patterns. A well promoted program may be assumed to reach 20 percent of households over a 10 year period.

d. A commercial/industrial water audit program from 2000 to 2004. A typical five year program would review how water is used for sanitary and landscaping purposes, as well as for process, boiler feed, cooling and air conditioning uses. Based on experience in other areas, it was assumed that 25% of industrial users and 5% of commercial users would participate, and would decrease water commercial/industrial water use by 15% at the end of the five year program.

Complete details on this alternative are included in Municipal and Industrial Water Use Forecasts. Volume I: Technical Report.

Conservation of Agricultural Water. The Natural Resources Conservation Service developed estimates of the water use savings that would result from increased use of water conservation measures in agriculture. The measures are listed in **Table 26**, and savings over time are shown in **Figure 37** and **Figure 36**.

Table 26. Measures Included in Agricultural Water Use Forecasts with Conservation

Category	Potential Water Conservation Measures Considered
Crops and Orchards	Conversion from travelers to center pivot (no guns) Irrigation scheduling Low energy, precision application Drip irrigation Computerized crop simulation models Low volume micro sprinklers for orchards New machinery that loosens compacted soil in orchards to reduce runoff
Turf	Irrigation scheduling Conversion from traveler irrigation guns to center pivot irrigation systems
Nurseries	Ebb and flow irrigation techniques Drip/trickle irrigation Micro-spray Solid set sprinklers Water reuse Hand watering
Aquaculture	6/3 pond water management system Water reuse Partial harvest Better harvesting equipment

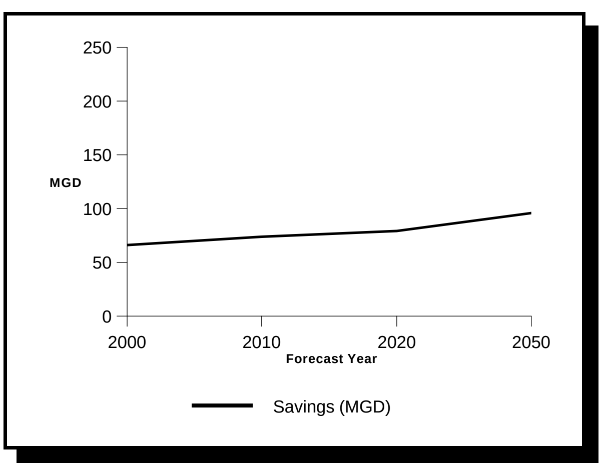

Figure 37. ACT Agricultural Conservation Savings

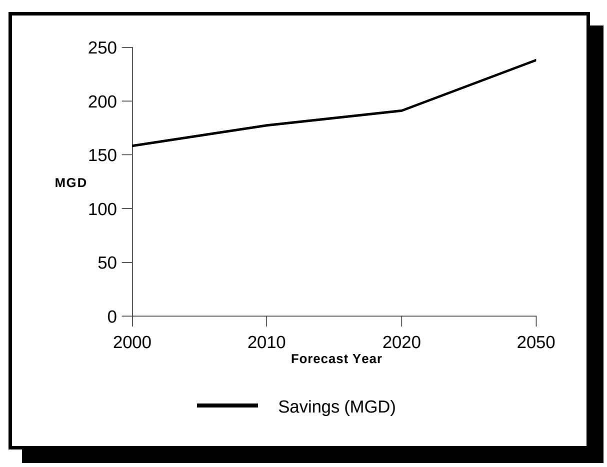

Figure 36 ACF Agricultural Conservation Savings

C. Combining Components to Create Basinwide Management Alternatives. The preceding section described the components that can be combined into an alternative in the Shared Vision Model. The partners have, since April 1996, used the draft and earlier versions of the model to assess the future of these basins under existing and alternative water management plans. This process will be accelerated during the final months of the basinwide study.

In this section, four alternatives in the ACF and three in the ACT are formulated, and in the next chapter, evaluated and compared to the reference condition as a demonstration of the current model allows this to be done

D. ACF Alternatives

Georgia, Florida, and the Mobile District have each developed alternatives for the ACF basin. Georgia requested that a specific alternative be formulated and evaluated in the Shared Vision Model. Florida ran a suite of alternatives, and an alternative similar to one of those was selected for this report. The Mobile District asked for a specific alternative to be formulated and evaluated. Alabama has not provided the University of Washington with specific alternatives, but has generally stated its interest in meeting certain objectives. The first alternative formulated below addresses those objectives.

Alternative 1. Alabama has expressed an interest in a coordination mechanism built on the concept that flows into the state of Alabama would always stay above a certain minimum level. This would preserve Alabama's potential to grow in the future. Alabama has also supported greater reliability for the navigation channel and for lake elevations that encourage recreation in Alabama. The goal of the first ACF alternative is to outperform the reference condition rules in meeting those objectives. The design elements include:

> To improve low flows into Alabama, the target flow for the Chattahoochee River was increased from 1,150 cfs to 1,650 cfs. Support for the higher target would come from Lakes Lanier and West Point.
>
> "Rule Curve" operation was selected to allow a constant 2.5 hours of peak generating time during the week. In the Water Control plan, peaking durations increase from 2 to 4 hours in the summer, except when lakes drop below their highest conservation pool zone, in which case peaking hours are reduced to two.
>
> To improve recreational opportunities at West Point and Walter F. George, the top of conservation pool was not dropped during the winter. By not drawing the lakes down each winter, additional water was made available in dry years to meet demands without drawing the lakes down to levels undesirable for recreation.
>
> Drawdown of West Point was limited to 628 feet; at that elevation, releases from the reservoir could be no greater than the inflows.

The navigation channel was improved with a Chipola cutoff weir, training dikes, and dredging so that nine foot depths could be sustained with as little as 9,300 cfs (see **Figure 28**). A preliminary estimate of the average annual costs of these improvements is $9.4 million per year (see **Table 24**). The navigation channel depth target was varied according to the amount of storage available, as in the Water Control Plan. A 12-day navigation windows was imposed whenever the amount of water stored in the ACF system fell to 60 percent or less of total capacity.

Alternative 2. Although the Georgia Environmental Protection Division has made over a hundred alternative runs using the Shared Vision Model, one "Georgia" alternative is shown here to demonstrate the capability of the model. The alternative was designed to address the Georgia decision criteria (**Table 6**). The components are:

An interbasin transfer of 150 MGD was made from the Coosa River to the Chattahoochee River above Peachtree Creek;

Rule curve operations were selected, with reduced minimum continuous release from Lakes Lanier, West Point, or Walter F. George of 350 cfs;

Winter pool elevations were raised to summer pool levels at Lanier, West Point, and Walter F. George;

No storage at Morgan Falls was used to re-regulate Lanier releases;

Lake Lanier support for navigation, and Lanier and West Point support for the 5000 cfs target at Blountstown was eliminated;

Monthly peaking releases were reduced to one hour per week day at Lanier, two hours at West Point and Walter F. George.

Alternative 3. The design objectives of the Corps of Engineers spring from its legal requirements to act according to Federal law and its *de facto* role as the first mediator of basin disputes. The Water Control Plan is an example of that philosophy. The alternative offered by the Mobile District at the April Alternatives Workshop includes the following components:

Use the Water Control Plan, but redefine navigation support so releases sufficient for 9 feet of channel depth are made when reservoirs are fullest (Zone 1), 8 feet in Zone 2, and 7½ feet in Zone 3;

Operate Corps hydropower plants to match the new SEPA peaking requirements. These requirements have not been published yet, so an estimate of a constant 2.5 hours of peaking energy was used as a surrogate;

M&I conservation in Georgia (Scenario 3). No cost estimates were developed for implementation in Georgia alone.

Return water used in Gwinnette County to Lanier (after the year 2000);

Return water used in Forsyth County to the Etowah River;

Lower the top of conservation pool at Lanier to 1067 in November, December, and January.

Alternative 4. Florida's goal is to preserve the Apalachicola Bay ecosystem, an ecosystem that has developed in adaptation to the variety and magnitude of flows into the Bay. Thus, a primary design objective for Florida would be to keep future flow patterns into the Bay from changing significantly. Increasing consumptive uses would, in general, reduce those flows, potentially increasing average salinity levels in the Bay and changing the flow of nutrients into the Bay.

Alternative 4 was built of the following components:

The top of conservation pools in all reservoirs was raised one foot, effectively increasing the amount of storage available in the system;

An alternative Blountstown target flow was used: 6,900 cfs for July through November, and 13,800 cfs from January to April, and 9,200 cfs for May, June, and December. These are percentages of the average annual flows offered as general guidelines in "A Recommended Method to Protect Instream Flows in Georgia".

Agricultural conservation (no cost estimate available).

In most of the runs made by the Northwest Florida Water Management District, the bottom elevation of Lanier was raised, but that component was not used by the University of Washington so that the effects of the seasonal flow targets for Blountstown could be isolated.

Table 27. Model Settings to Define the ACF Alternatives Described in This Report

Alternative ➔	1 (AL)	2 (GA)	3 (Corps)	4 (FL)
Settings in the STELLA II Model				
OperatingSystemsSwitch	1	1	0	0
BuPeakHrsMonth	2.5	1		
BuPeakHrsWCP			2.5	
LanConsElev (for November and December)			1067	
LanConsElev (every month)		1071		+1 foot
LanBotConsElev		1064		
BuMinCont		350		
BuNavSupSw		0		
ConsCurtTrigger		0		
Use MFStor cfsd		750		
WPPeakHrsMonth	2.5	2		
WPPeakHrsWCP			2.5	
WPConsElev	635	635		+1 foot
WPBotConsElev	628			
WPMinCont		0		
ColumbusTarFlow *cfs*	1,650	1,150		
XferFromCoosa		150		
WFGPeakHrsMonth	2.5	2		
WFGPeakHrsWCP			2.5	
WFGConsElev	190	190		+1 foot
BlountsMin cfs - January-April				13,800
BlountsMin cfs - May - June				9,200
BlountsMin cfs - July - November				6,900
BlountsMin cfs - December				9,200
SelectNavAltSw	1	0		
NavSwitch	2	1		
NavWinOption	2	0		
NavWinSwitch	1	0		
NavWin%StorTrig	60%			
In SVMDEM.XLS (Excel Workbook)				
M&I Scenario	2	2	3	2
Ag Conservation	2	2	2	1
M&I Rerouting Option 1 (Gwinette to Lanier)			2	
M&I Rerouting Option 5 (Forsyth post 2010 to Etowah River			2	

E. ACT Alternatives. Georgia and the Corps provided specific ACT alternatives. An alternative that addresses objectives inferred from Alabama's expressed interests was formulated by the University of Washington and is described below.

Alternative 1. As in the ACF, Alabama has expressed support for the navigation project, minimum flows entering Alabama from Georgia, and water related recreation on the ACT. The University of Washington formulated an alternative to address those objectives consisting of these components:

A West Georgia Reservoir with a top elevation of 1010', and an operating plan that attempts to release at least 30% of the average annual flows;

The navigation channel was improved with training dikes, and dredging so that nine foot depths could be sustained with as little as 5,000 cfs (see **Figure 35**). A preliminary estimate of the average annual costs of these improvements is $7.4 million per year (see **Table 24**). Navigation support from Carters and Allatoona was eliminated, as was support from Alabama Power Company dams for the combined Jordan-Bouldin-Thurlow target after it was determined that 100% reliability of the navigation channel could be obtained without this support.

Carters and Allatoona were operated to meet a 1500 cfs target flow in the Coosa River at the Alabama state line;

Winter pool elevations were raised to summer levels at the Alabama Power Company reservoirs to increase the effective storage of the ACT system.

Alternative 2. The Corps offered a modification to the reference condition on the ACT. This alternative:

Is based on the rules of the Water Control Plan;

Operates Corps hydropower plants to meet new SEPA requirements. Since those requirements have not been published yet, a constant peak release of 2.5 hours was used as a surrogate;

Include the West Georgia Reservoir (elevation 1010 feet, 4000 acre-foot variant);

Returns water used in Forsyth County to the Etowah River;

Improves the navigation channel with training dikes and dredging to obtain 9 feet of channel depth with as little as 6600 cfs (see **Figure 34**). A preliminary estimate of the average annual costs of these improvements is $3.5 million per year (see **Table 24**).

Eliminates support from Alabama Power Company dams for the combined Jordan-Bouldin-Thurlow flow target;

Lowers the top of the Carters conservation pool to 1060 feet from August 1 to January 1.

Alternative 3. One of the ACT alternatives developed by Georgia to address their management objectives consists of the following components:

Add a West Georgia Reservoir (elevation 1010 feet, 4000 acre-foot variant) that provides at least 7Q10 releases;

Eliminate support from Carters and Allatoona for navigation and state line flows;

Account for the 150 MGD transfer from the Coosa River used in the Georgia ACF alternative;

Generate peaking energy for 4 hours per workday at Allatoona, and 2 hours per workday at Carters

Use "rule curve" operations, and raise winter pools to summer pool elevations to increase the effective storage of the ACT system;

Table 28. Model Settings For the ACT Alternatives Shown in This Report

In the Stella II® Model			
ACT Alternative Number	1(AL)	2 (Corps)	3 (GA)
WestRuleElev	1010	1010	1000
WestContRelSwitch	2	1	1
ConsStorCurtTrigger	0	0	0
JorTarFlowcfs	2,000	2,000	2,000
ThuTarFlowcfs	1,200	1,200	1,200
GAALCoosaTarFlowcfs	1500	0	0
GAALTallaTarFlowcfs	200	0	0
Mont, and ClaTarFlowcfs	0	0	0
APCoNavTarFlowcfs	4,640	4,640	4,640
NavSwitch	2	2	1
ClaNavDepth	9	9	0
NavFlowSwitch	3	2	0
NavUseCorps	0	0	0
WeiEndRuleElev	564	Default	Default
HNHenEndRuleElev	508	Default	Default
LogEndRuleElev	465	Default	Default
HarEndRuleElev	793	Default	Default
MarEndRuleElev	490	Default	Default
PeakHrsSwitch		1	0
CarPeakHrsMO		2.5	2.5
Weis,HNHen,Log,Har,Mar PeakHrs			0
AllaPeakHrsMO		2.5	4
AddXferfromCoosa		100	150
RecImpactSwitch			0
In SVMDEM.XLS (Excel Workbook)			
M&I Rerouting Option 4		2(on)	
M&I Rerouting Option 5 (Forsyth post 2010 to Etowah River)		2(on)	

VII. USING THE SVM TO EVALUATE ALTERNATIVES

A. Overview. The four ACF and three ACT alternatives formulated in the previous chapter were evaluated using the same performance measures used to assess whether future water needs could be met under the operating rules of the reference condition. **Table 29** shows the performance of the ACF alternatives with 1990 demands, **Table 30** shows the performance of the same alternatives when demands increase to 2050 levels. **Table 31** and **Table 32** show how well the ACT alternatives perform under 1990 and 2050 demands. The performance of the system under reference condition rules is shown in those tables for comparison.

These tables are provided to show the type of analysis that can be done with the models. The partners have already run many other alternatives in an attempt to test the models and develop an intuitive feel about how the system works. As a result, we hope to report on more effective alternatives in the final report.

These tables do not show any of the ***effects*** of these alternatives, since the effects functions were not available in time to be included in the draft model. We expect that the final (September 1996) model will include draft navigation tonnages and benefits for both basins. We hope to include recreation visitation, NED benefits, and local and regional spending, as well as reservoir fisheries, riverine, and wetland environmental scores. It appears unlikely at this point that the dependable capacity and economic benefits from hydropower production will be available in time to be included in the model.

The analyses the Mobile District Corps of Engineers would conduct prior to recommending major changes in storage allocation or reservoir operation, or construction of additional channel features such as dikes or locks would depend on these effects, so their inclusion in the shared vision models and planning process is essential.

Table 29. Performance in the ACF, Basinwide Alternative Plans, 1990 Demands

	Reference Condition	ALTERNATIVE 1 (AL)	2 (GA)	3 (Corps)	4 (FL)
Consumptive Demands					
Reliability, All Reaches	**100**	**100**	**100**	**100**	**100**
Water Quality Targets					
PTC Reliability	**100**	**100**	**100**	**100**	**100**
Columbus Reliability	**100**	99.1	**100**	**100**	**100**
Columbus Vulnerability	**0**	209	**0**	**0**	**0**
Recreation					
Lanier (stay within 5' of top)	58.9	65.1	**99.1**	56.5	53.0
Lanier Vulnerability (feet)	6.4	5.9	**1.0**	7.2	8.4
West Point (stay within 3')	74.2	93.3	**100**	74.1	75.6
West Point Vulnerability (ft)	3.6	2.6	**0**	3.5	3.6
WF George (stay within 3')	89.5	95.8	**100**	88.9	88.5
WF George Vulnerability (ft)	1.1	1.3	**0**	1.1	1.0
Navigation					
Reliability, 7 ½ ft channel	88.6	**93.9**	81.0	88.6	88.6
Vulnerability @ 7 ½ ft (cfs)	1,972	**1,391**	1,876	1,776	1,942
Reliability, 9 ft channel	73.9	**83.5**	62.8	75.3	78.6
Vulnerability @ 9 ft (cfs)	3,335	**2,243**	3,283	3,360	3,651
Hydropower					
Buford Reliability (%)	49.6	46.7	**76.5**	54.8	53.0
West Point Reliability (%)	91.1	87.4	**95.5**	93.6	91.1
W.F. George Reliability (%)	96.5	95.6	**100**	97.3	97.3

The best performance in each measure is shown in bold.

Table 30. Performance in the ACF, Basinwide Alternative Plans, 2050 Demands

	Reference Condition	ALTERNATIVE 1 (AL)	2 (GA)	3 (Corps)	4 (FL)
Consumptive Demands					
Reliability, All Reaches	**100**	**100**	**100**	**100**	**100**
Water Quality Targets					
Peachtree Creek Reliability (%)	**100**	**100**	**100**	**100**	**100**
Columbus Reliability (%)	**100**	98.3	**100**	**100**	**100**
Columbus Vulnerability (cfs)	0	231	**0**	**0**	**0**
Recreation					
Lanier Reliability (%)	50.2	55.8	**94.7**	53.6	53.0
Lanier Vulnerability (feet)	8.1	8.0	**2.5**	8.6	8.4
West Point Reliability (%)	70.7	91.1	**99.9**	71.8	75.6
West Point Vulnerability (ft)	3.5	2.6	**0.3**	3.5	3.6
Navigation					
Reliability, 7 ½ ft channel	85.6	**91.7**	77.6	86.0	87.3
Vulnerability @ 7 ½ ft (cfs)	2,291	**1,611**	2.066	2,080	2,303
Reliability, 9 ft channel	72.1	**81.3**	60.1	72.4	75.7
Vulnerability @ 9 ft (cfs)	3,749	**2,562**	3,566	3,589	3,767
Power					
Buford Reliability 1 (%)	43.3	42.3	**66.0**	51.8	46.4
WPEngReliability	90.6	84.4	**95.1**	92.4	89.4
W.F.George Reliability (%)	**100**	95.5	**100**	96.2	97.0

The best performance in each measure is shown in bold

Table 31. Performance in the ACT, Alternative Basinwide Plans, 1990 Demands

	Reference Condition	Alternative 1 (AL)	Alternative 2 (Corps)	Alternative 3 (GA)
Consumptive Demands				
All Reaches but 11, 13, 20 (%)	**100**	**100**	**100**	**100**
Reaches 11 and 13	**99.9**	**99.9**	**99.9**	**99.9**
Reach 20	**100**	**100**	**100**	**100**
Alabama State Line Flows				
Coosa Minimum flow (cfs)	1,274	**1,500**	1,116	1,042
Recreation - Stay Within 3' of top				
Carters Reliability (%)	**100**	99.9	**100**	**100**
Carters Vulnerability (ft)	**0**	0.5	**0**	**0**
Allatoona Reliability (%)	96.5	96.5	**98.0**	96.5
Allatoona Vulnerability (ft)	**4.5**	4.6	8.1	4.5
Weiss Reliability (%)	99.1	**99.4**	99.1	99.2
Weiss Vulnerability (ft)	0.8	**0.7**	1.3	0.5
Lake Martin Reliability (%)	99.2	**99.4**	99.1	99.1
Lake Martin Vulnerability (ft.)	2.8	**2.1**	3.6	2.5
Navigation				
Reliability of 7 ½' channel (%)	88.9	**100**	100	88.0
Vulnerability @ 7 ½ (cfs)	1,658	0	0	1,741
Reliability of 9' channel (%)	84.5	**100**	99.5	83.0
Vulnerability @ 9' (cfs)	2,052	**0**	945	2,081
Power - Average Hours Generation				
Allatoona	**7.37**	7.22	7.05	**7.37**
Carters	2.05	2.06	**2.59**	2.05
Harris	**4.51**	4.43	**4.51**	**4.51**
Weiss	**11.11**	10.98	10.84	10.81

Best performance against each measure shown in bold

Table 32. Performance in the ACT, Alternative Basinwide Plans, 2050 Demands

	Reference Condition	Alternative 1 (AL)	Alternative 2 (Corps)	Alternative 3 (GA)
Consumptive Demands - Reliability				
All reaches but 10, 11, 13, and 20 (%)	**100**	**100**	**100**	**100**
Reach 10	99.4	**100**	**100**	**100**
Reach 11 & 13	**99.9**	**99.9**	**99.9**	**99.9**
Reach 20	**98.8**	**98.8**	**98.8**	**98.8**
Alabama State Line Flows				
Coosa Minimum Flow (cfs)	1,200	**1,500**	1,041	968
Recreation - Stay Within 3'				
Carters Reliability (%)	**100.0**	99.9	**100**	**100.0**
Allatoona Reliability (%)	96.4	96.4	**97.4**	96.4
Allatoona Vulnerability (ft)	**4.7**	4.9	8.4	**4.7**
Weiss Reliability (%)	99.1	99.1	99.1	**99.2**
Weiss Vulnerability (ft)	**0.8**	0.9	1.4	1.0
Lake Martin Reliability (%)	99.1	**99.4**	98.8	98.9
Lake Martin Vulnerability (ft)	2.8	2.8	2.9	**2.5**
Navigation				
Reliability of 7 ½' channel (%)	87.3	**100**	99.7	86.3
Vulnerability @ 7 ½ (cfs)	1,778	**0**	571	1,843
Reliability of 9' channel (%)	82.4	**100**	99.4	80.9
Vulnerability @ 9' (cfs)	2,166	**0**	1,412	2,196
Power - Average Hours Generation				
Allatoona	7.22	**7.22**	6.67	7.22
Carters	2.05	2.06	**2.59**	2.05
Harris	4.42	**4.43**	4.42	4.42
Weiss	10.97	**10.98**	10.63	10.67

Best performance against each measure shown in bold

B. Would the Partners' Criteria Be Met By These Alternatives?

The sheer number of performance measures in the tables on pages 72-75 makes it difficult to determine if the partners' decision criteria have been met, and those tables reflect just a fraction of the measures the shared vision model calculates (see the Appendix, starting on page 83, for a full list of measures of performance available from the Shared Vision Model). This is a well known problem in interpreting computer results, and it can be useful to develop simpler "bottom line" tables to support a judgement on alternatives. The author's (not the partners') reduction of the results according to major decision criteria except Blountstown flows is shown in **Table 33**. This particular table is intended to show only how the large amount of data the Shared Vision Model can generate can be summarized in a way that allows decision makers to revise or select plans with greater assurance. Although this table was generated by one person, tables like this can be developed in small group processes with stakeholders. Doing so increases the general understanding and support for decisions.

These are first attempts at designing alternatives. None of these alternatives is better than the reference condition for all criteria, but some offer interesting tradeoffs, and could serve as the basis for the formulation of additional alternatives.

ACF Alternative 1 induces an apparent decline in the reliability of instream flows at Columbus, but this is measured against a higher (1,650 cfs versus 1,150 cfs) standard. Recreation levels at Lanier, West Point and Walter F. George are better than the reference condition, and the navigation channel reliability improves significantly. Overall, this alternative appears to meet the criteria that have been used to represent Alabama's perspective. The Corps of Engineers would have to evaluate the economic benefits of the additional $9.4 million in average annual costs. This alternative meets Georgia's desire to keep lakes high for recreation better than the reference condition.

ACF Alternative 2 outperforms the reference condition against every decision criterion shown except navigation reliability, and the reliability of recreation at Lanier increases substantially.
ACF Alternative 3 does well for power, but not much else. Alternative 4 performs a little worse overall than Alternative 3.

Table 33. A Subjective Summary of How Well Alternatives Met Decision Criteria

The table below compares how well alternatives performed compared to the reference condition in each basin. If the reference condition were shown, it would be scored "0" under each criterion. If an alternative does better, it receives a "+"; much better, a "++". Under the reference condition, for example, recreation reliability at Lanier falls from 59% to 50% (1990 to 2050 demands), but under the ACF2 alternative, desirable recreation depths were available 93% of the time with 1990 demands, and 89% with 2050 demands. A "-" or "--" score means the alternative did worse, or much worse than the reference condition. Under ACT2, for example, lake recreation reliability was much worse than under the reference condition.

The partners have not provided a final set of criteria, but any alternative with all "0"'s or "+"'s would be preferable to the reference condition according to the criteria used. None of these alternatives meets that test. On the other hand, a "-" in one criterion does not mean the alternative must be rejected; it can be revised and tested again, or winners can negotiate with losers. This is essentially what happens in a typical Corps reallocation study, when (for example) M&I stakeholders pay power stakeholders the cash value of lost power.

DECISION CRITERIA	ACF 1	ACF 2	ACF 3	ACF 4	ACT 1	ACT 2	ACT 3
Highest reliability of consumptive demands	0	0	0	0	0	0	0
Highest reliability of PTC, Columbus flows	-	0	0	0	N/A	N/A	N/A
Meets 7Q10 Flows at Alabama Border	N/A	N/A	N/A	N/A	-	0	0
Carters, Allatoona, Lanier kept high for rec	+	++	-	-	-	- -	+
Supports hydropower	-	0	+	0	+	-	0
Navigation prospers	+	-	-	+	++	++	-
Alabama water supply preserved for future	0	0	0	0	0	0	0
Alabama lakes kept high for recreation	-	-	0	-	+	0	0

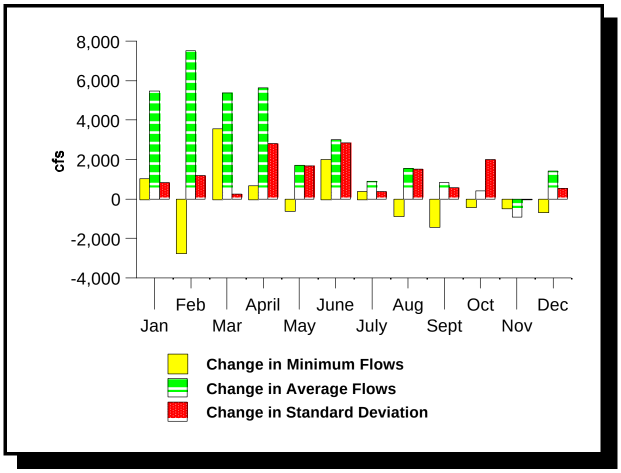

Figure 38. Blountstown Flows, ACF 4 versus Historical

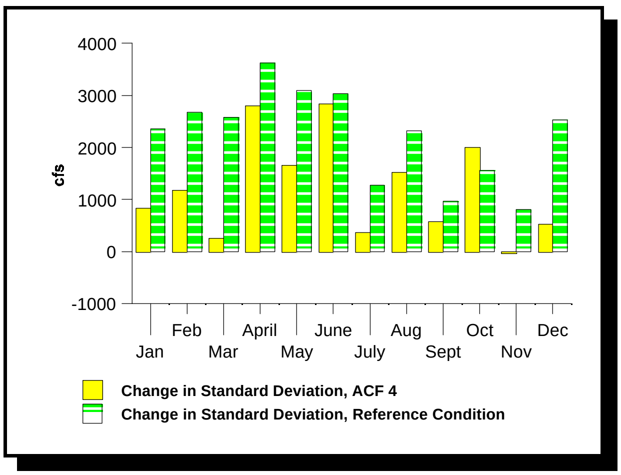

Figure 39. Similarity to Historic Blountstown Flows: ACF4 vs Reference

Figure 38 compares historic flows at Blountstown to the flows predicted under ACF Alternative 4 and 2050 demands. The graph depicts the change in minimum and average flows and the standard deviation of flows for each calendar month. Flows with less variability might have a smaller standard deviation. Using reductions in the standard deviation of monthly flows from historic patterns as one measure of variability, the flows under Alternative 4 are closer to the historical regime in every month than the reference condition flows with 2050 demands (**Figure 39**). Nonetheless, the standard deviations of flows under this alternative are less than historic except in November, decreasing by as much as 2,800 cfs in April and June. This is one way to assess an alternative against Florida's primary decision criterion; when riverine habitat scores are integrated into the Shared Vision Model, there will be even more information to fold into the decision making process. The challenge then will be to decide what particular measures of similarity to pay most attention to, and how to value incremental changes in those measures.

The ACT reference condition shows few problems except for navigation, so it may not be surprising that there are few differences in the performance of alternatives, and that none are clearly superior to the reference condition.

ACT Alternative 1 helps navigation significantly, and the minimum state line flows on the Coosa River is the highest for any alternative.

ACT Alternative 2 outperforms the reference condition in navigation, but hurts power a little.

ACT Alternative 3 performs nearly on par with the reference condition, with less power generated at the private power dams, lower minimum state line flows on the Coosa River, and a slight decrease in the reliability of navigation.

C. Testing the Model

The shared vision model design is essentially complete. Additional modules for riverine fisheries, wetlands, recreation visitation and economics, and navigation tonnages and economics have recently been added.

The model needs to be thoroughly tested to make sure that it returns consistent and sound estimates of system performance. Simpler versions of this model, called the ACT and ACF Water Balance Models, were throughly tested, but since that time the model has become several times larger with alternative formulation controls, groundwater-surface water links, data from additional forecast years, groundwater use data, slider bars for sensitivity analysis (both by reach and universal), and dozens of new measures of performance. In addition, the model was transformed by the use of Dynamic Data Exchange (DDE) and the Excel® spreadsheets. The draft model has been used to run hundred's of simulations already, and modeling outputs change progressively and as expected with changes in model inputs. For example, the reliability of navigation and recreation levels drop incrementally as demands increase. Changes in slider bar positions produce results that change in the expected direction. There was an extensive review in July and early August of the translation of the agricultural data into the Shared Vision Model. That review found only 2 small errors in the model; those errors changed demand by about 1 MGD.

But the real value of shared vision models is realized when the model is so trusted that the validity of its results is no longer an issue. The best test of a model designed to formulate and evaluate alternatives is to formulate and evaluate alternatives, and to use the many sensitivity controls.

D. Adaptive Management - Using the Models after 1996

The shared vision model was designed to be used in the Comprehensive Study, but it can be adapted to several other uses, including drought contingency planning studies, interactive gaming exercises in an operational setting (short time step, fixed demands, meant to simulate real time operation), and development of flow standards for the Coordination Mechanism agreements. Because 55 year forecasts will certainly be wrong to some degree, and because our knowledge of the relationships between water, the environment, and the economy should improve with time, the model should be updated in the same collaborative fashion that was used to construct it.

Use for drought planning. The purpose of the Comprehensive Study was not to develop drought preparedness plans, but the development of such plans would be greatly helped by the collaborative products developed during the Comprehensive Study, and it is one logical next steps for the partners to consider. Certain caveats must be attached to the employment of Comprehensive Study water use data to determine how well the basins would do during a drought. In the early stages of a drought (or in a short duration drought) water use is higher than normal as lawns and crops are watered more than usual. When drought response measures are imposed, municipal water use typically declines below normal levels. Fairly careful studies of water use in California cities during the 1980's droughts indicated that municipal water use consumption was reduced from 10 to 25% by drought response measures such as temporary water price increases, outdoor water use restrictions, and public awareness campaigns. These percentages vary from region to region, and can change in the same region over time as long term conservation measures become effective.

The amount of water used for irrigation during a drought has not been estimated during the Comprehensive Study. The NRCS estimates in Appendix B-32 are based on crop needs, but it would also have to be determined whether actual water use would be reduced by physical and regulatory limitations.

An Interim Drought Management Plan (IDMP) was completed in April, 1985, and a Drought Management Committee was formed soon thereafter; some information might be available from those efforts. In order to develop a drought preparedness plan, the partners would need to:

1. Estimate agricultural water use during droughts. One such estimate was made during the Comprehensive Study. Upton Hatch (working for NRCS) estimated that irrigation for corn, peanuts and soybeans would be about 300 MGD per year in those years that ranked in the bottom fourth for precipitation, while irrigation in a normal year would be about 300 MGD.

2. List past and potential municipal and industrial drought preparedness measures (Georgia communities have employed drought response measures as recently as the summer of 1996), and an estimation of the reduction in water use from those measures. Existing measures for other uses, such as navigation windows, could be listed and improvements suggested.

3. Develop and test drought response triggers such as "days supplies remaining" in reservoirs.

4. Determine the frequency of historic droughts, and whether it is appropriate it is to plan for larger droughts.

5. Determine who makes decisions during droughts, and what modeling timestep would be necessary to realistically simulate future drought responses.

6. Develop an integrated public information campaign as needed.

7. Design and execute a "virtual drought".

8. Assign institutional responsibilities for integrated drought responses and determine how drought information, including a shared vision model for drought response would be maintained and updated.

Use in Corps reallocation and authorization studies. The Comprehensive Study data, reports, models, and collaborative relationships could be used in any reallocations studies the Corps conducted following the Comprehensive Study. This is particularly true of the basinwide model and report, which provide much of the information and analysis needed to make a reallocation recommendation. As discussed previously, the Corps is bound by Federal rules and agency regulations to consider economic and environmental benefits in its decisions. If the Corps recommendations from such studies are to reflect a basinwide perspective, it is essential that collaboration among the partners continue through the review and acceptance of the economic and environmental studies nearing completion now.

Use of the Shared Vision Model in Establishing and Testing Requirements from an Interstate Compact. The partners are currently considering an interstate compact whose primary initial purpose would be to establish flow requirements at state lines. The Shared Vision Model could help determine how and whether such requirements could be met, and the opportunity costs for meeting them.

APPENDIX: SHARED VISION MODEL CONTROLS AND MOP'S

Demand Controls within SVMDEM.xls (ACT and ACF)

Demand Year This variable may be changed in the excel spreadsheet "svmdem.xls". This variable controls which year's demand estimates are active in the model. It sets the year for which demand estimates are generated. 1 = 1990, 2 = 2010, 3 = 2050.

Demand Forecasts

Municipal & Industrial Demand Forecasts (PMCL)

The *M&I Scenario* cell in the spreadsheet "svmdem.xls" may be set to the following available scenarios : No Conservation (1), Passive Conservation (2), Aggressive Conservation (3).

Years available: 1990, 1995, 2000, 2005, 2010, 2015, 2020, 2025, 2030 and 2050

Agricultural Demand Forecasts (NRCS)

The *Agr. Scenario* cell in the "svmdem.xls" spreadsheet may be set to the following available scenarios: High (1), Expected (2), and Low (3).

The *Agr. Conservation* cell in the"svmdem.xls" spreadsheet may be set to the following available options: Conservation (1) and Without Conservation (2)

Years available 1992, 1995, 2000, 2010, 2020 and 2050 (NOTE: 1992 should not be selected in the all demands control options sector. When 1990 is selected 1992 forecasts are used for agriculture. 1992 should be used in the Agr. control options sector).

Thermal Demand Forecasts

Years Available 1994-2010 (NOTE: 1994 should not be selected in the all demands control options sector. When 1990 is selected 1994 forecasts are used for thermal. 1992 should be used in the thermal control options sector).

M&I Rerouting Options

Gwinett Out-of Basin: This variable may be set in "svmdem.xls" to:
Status Quo Gwinnet (Chattahoochee) out of basin transfers returned out of basin.
Gwinnett (Chattahoochee) out-of-basin transfer returns to Lanier. (Return factor of 86% is used for this portion of the withdrawal)
Gwinnett (Chattahoochee) out-of-basin transfer returns to Peachtree Creek. (Return factor of 86% is used for this portion of the withdrawal)

Paulding (Chattahoochee, Coosa and Tallapoosa): This variable may be set in “svmdem.xls” to:

1. Status Quo Paulding (Chattahoochee, Coosa and Tallapoosa) post trigger year increased demands (default 2010), assigned to Peachtree Creek; returns to CarAllatoRome.
2. Paulding (Chattahoochee, Coosa and Tallapoosa) post trigger year increased demands (default 2010), assigned to CarAllatoRome; returns to CarAllatoRome
3. Paulding (Chattahoochee, Coosa and Tallapoosa) post trigger year increased demands (default 2010), assigned to West Georgia Reservoir; returns to CarAllatoRome.

Douglas (Chattahoochee)This variable may be set in “svmdem.xls” to:

1. Status Quo Douglas (Chattahoochee) post trigger year increased demands (default 2010), assigned to West Point; returns to West Point.

2. Douglas (Chattahoochee) post trigger year increased demands (default 2010), assigned to West Georgia; returns to West Point

Cobb (Chattahoochee and Coosa): This variable may be set in “svmdem.xls” to:

1. Status Quo Cobb (Chattahoochee) demands and returns assigned to Peachtree Creek and West Point plus interbasin transfer from Allatoona (via Bartow); returns to Peachtree Creek and West Point

2. Cobb (Chattahoochee-Peachtree Creek) demands assigned to Allatoona; returns to Peachtree Creek and West Point

3. Cobb interbasin transfer eliminated, transfer demands assigned to Peachtree Creek; returns to Peachtree Creek and West Point

Forsyth (Chattahoochee and Coosa): This variable may be set in “svmdem.xls” to:

1. Status Quo Forsyth (Chattahoochee and Coosa) post trigger year demands (default 2010), assigned to Lanier; returns to Buford and Peachtree Creek.

2. Forsyth (Chattahoochee and Coosa) post trigger year demands (default 2010), assigned to Lanier; returns to Allatoona (Etowah)

Trigger Year: This variable may be set in “svmdem.xls” to the desired trigger year.

ACF Control Options

OperatingSystemSwitch The user may use this slider to select the operating system to be used in the model run.

> 0 = Water Control Plan (PAC Study 1989 with updated navigation flow targets)
> 1 = Rule Curve operations without zones

Use MF stor cfs-d This slider enables the user to specify the useable storage available at Morgan Falls. This quantity affects continuous releases at Buford Dam due to re-regulation effects. Units cfs-days.

Demand Withdrawal Controls

Global Adjustment Factors for Withdrawals; Setting the curtailment factor sliders ***M&I CurtFact, AgCurtFact*** and ***ThermCurtFact*** selects a factor by which the demand withdrawals and returns are multiplied for each use. Note: Measures of performance will not indicate that the withdrawals have been curtailed unless reduced demands as specified cannot be met for other reasons (insufficient available water, for instance).

Demand Factor (*DemFact*); This slider sets the fraction of demands that are met when restrictions are triggered.

Restriction Trigger (*ConsCurtTrigger*); This slider sets the % of full conservation storage during the run that triggers restrictions. When restrictions are triggered, less demands are met. The effects of this control are shown in the measures of performance showing reductions in reliability and increases in vulnerability when restrictions become active.

Manual Overrides for Demand Withdrawals and Returns by river reach. Sliders are available for each river reach and are named *SumWithXXX*, *SumRetXXX* (where XXX is a surrogate for the name of the river reach, ex. BUtoPTC). Setting any of the sliders to "equation on"selects the PMCL estimates of demand and return (if other demand modifications are at default). Disabling the "equation on" setting allows the user to select a level of demand by setting it on the slider. The model will attempt to meet these new demands and will show reliability and vulnerability of new demands. Units mgd.

M&I and Agriculture Controls for Specific Reaches in the Upper and Lower Basin by month. Graphical functions are available that allow the user to specify adjustment factors for the following

> Lanier, Peachtree Creek and West Point M&I withdrawal and return adjustment factors.
> W.F.G., Jim Woodruff, UpFlint, MidFlint and Lower Flint agricultural adjustment factors

The number (set by the user) in the graphical functions is multiplied by the primary data and the model attempts to deliver a new demand within the constraint of available water (or other curtailment operations) and reports the reliability and vulnerability. Note that the user must explicitly specify all changes including inter-reach effects. Consult pipes data or demand spreadsheets for information about how adjusting demands effects returns in various reaches. Unitless.

Fraction of M&I and Agricultural demand supplied by groundwater pumping in selected reaches. Graphical functions are available that allow the user to specify this fraction. Controls for those reaches that have a direct connection between surface and groundwater have not been included since groundwater withdrawals are added to surface withdrawals and any adjustment to surface/ groundwater split would have no effect on surface hydrology. (Note: Do not set fraction from groundwater larger than 1.0).

Interbasin transfer; The graphical functions *Xfer from Coosa* and *Xfer from Tallapoosa* select the amount of additional interbasin transfers from the Coosa and Tallapoosa systems respectively, as a graphicalfunction by month. The numbers can be negative (a reduction in existing transfer) if desired. Units mgd.

SetCoosaIntZero Setting this switch to 1 eliminates the effects of interbasin transfers from Lake Allatoona and increases the surface withdrawal at the PTC reach accordingly to meet demand.

Instream Targets. The following are graphical functions which set new instream targets at the locations specified. These values are used for both WCP or Rule Curve operations.

BUMinCont: This graphical function allows the user to set the monthly values of minimum continuous release from Buford Dam. Default value is 500 cfs. Units cfs.

WPMinCont: This graphical function allows the user to set the monthly values of minimum continuous release from West Point Dam. Default value is 675 cfs. Units cfs.

PTreeCrkTarFlow This graphical function allows the user to set the monthly flow requirement at the Atlanta Gauge. Default value is 750 cfs. Units cfs.

ColumbusTarFlow This graphical function allows the user to set the monthly flow requirement at Columbus, GA. Default value is 1160 cfs. Units cfs.

JWMin This graphical function allows the user to set the monthly minimum release from JimWoodruff Dam. Note that this value is different from the variable below.

BlountsMin cfs This graphical function allows the user to set the minimum flow requirement at Blountstown. In the Water Control Plan this value is set as 5000 cfs and is required to supply downstream industrial users. Units cfs.

Hydropower Controls

Rule Curve Operations only;
The following sliders fix the hydropower peaking hours at the plants indicated for Rule Curve Operations only.

PeakingHrsSwitch This slider specifies the function to be used to determine the number of peaking hours. It allows the user to select one of two kinds of peaking hour graphical functions when the rule curve option is active. Setting the slider to a value of 0 selects peaking hours by month (See Peaking hours by month below). Setting the slider to a value of 1 selects peaking hours by reservoir elevation (see Peaking Hours by Reservoir Elevation below).

PeakingDaysPerWeek This slider specifies the number of peaking days per week. Options are 5 or 7 peaking days per week only. A peaking day is defined as a day for which there is a peaking event. So, for example, if there were seven peaking daysper week there would be a peaking event each day of the week.

Peaking Hours by month. The user may set the number of peaking hours as a function of month for Buford Dam, West Point Dam and W.F. George Dam by setting the graphical functions *BUPeakHrsMonth, WPPeakHrsMonth* and *WFGPeakHrsMonth* respectively. The units are hours.

Peaking Hours by Reservoir Elevation The user may set the number of peaking hours as a function of reservoir elevation for Buford Dam, West Point Dam and W.F. George Dam by setting the graphical functions *BUPeakHrsElevation, WPPeakHrsElev,* and *WFGPeakHrsElev* respectively. The units are hours.

WCP Operations only:

The sliders *BUPeakingHrsWCP*, *WPPeakingHrsWCP* and *WFGPeakHrsWCP* fix the hydropower peaking hours per peaking day at Buford Dam, West Point Dam and W.F.George Dam respectively when the WCP operating system is active. The Corps Water Control Plan allows a minimum of 2 hours of generation at penstock capacity per weekday (5 days per week). A minimum of 4 hours per weekday is allowed from July to October provided storage is above zone 3. These numbers represent the minimum peakgenerating hours, actual releases may allow greater generating times.

Buford Re-regulation The user may simulate a re-regulation dam below Buford Dam by setting ***BUContRel _cfs*** to zero. ***BUContRel _cfs*** is the estimated 24 hr continuous release made from dam in units of cfs. Peachtree Creek Target flows and minimum continuous releases at Buford Dam will still be supported by model release calculations for either WCP or Rule Curve Operations.

Number of Peaking Days per Week The slider ***PeakingDaysPerWeek*** specifies the number of peaking hours per week for all federal dams. Options are five days and seven days per week. The control works for both WCP and Rule Curve Options.

Dependable Capacity MOP Control ***PeakLoadHrs*** is used to specify the number of hours by which minimum firm energy is divided by to estimate dependable capacity.

Peaking Discharges for Federal Projects ***BUPenCap***, ***WPPenCap***, and ***WFGPenCap*** sliders may be used to specify the penstock capacity for Buford, West Point, and WF George. Units cfs.

Maximum Deficit Algorithm Controls

The controls below activate an operating system that tracks the storage/inflows necessary to supply all of the established needs in the system while showing the effects to the system of supplying these needs. All measures of performance can be used in the model except measures of performance for hydropower which rely on head in reservoirs.

The Maximum Deficit technique should only be used with the ***OperatingSystemSwitch*** (mentioned previously) set to Rule Curve Operations since WCP navigation calculations are based on volume of water in each zone--parameters that do not exist during some phases of a Maximum Deficit run. Deficits are in units of cfs-days.

MaxDeficitSwitch This slider allows the user to choose to activate the maximum deficit calculations. This activation may cause a change in operating rules.

The following choices are available:

0 = This switch has no effect.
1 = The volume of water needed to meet all demands is tracked.

MaxDefTrigger% This slider allows the user to set the percent of system capacity that triggers the maximum deficit algorithm. System capacity is the actualconservation pool storage in Buford, West Point and WF George divided by their total full conservation pool storage. The purpose of setting this trigger is to meet navigation targets.

Conservation Pool Adjustment Controls

LanConsElev, *WPConsElev* and *WFGConsElev* graphical functions allow the user to set the elevation of the top of the conservation pool at Lake Lanier, West Point Reservoir and W.F.George Reservoir respectively. This converter shows the end of month value for the rule curve. STELLA displays beginning of month storage. The end of month value is used for computations. Units ft.

LanBotConsElev, WPBotConsElev, WFGBotConsElev graphical functions allow the user to set the elevation defining the top of the inactive volume of the reservoirs (Lake Lanier, West Point and W.F.George respectively) at the end of the month. This is also the bottom of zone 4 at the end of the month. End of month values of this variable are used for available water calculations to ensure that beginning of month reservoir storage values are not below the definition of the bottom of conservation pool for that month. Beginning of month values are used for graphing, to compute the zone value, and for other purposes needing the current month value. Units ft.

JWBotElev ft Lake Seminole Bottom ofConservation Pool. Top of conservation pool varies with tailwater elevation and is not directly adjustable.

Navigation Controls

SelectNavAltSw The slider selects the flow/depth relationship at Blountstown that controls releases and MOPs for navigation. These selections affect both WCP and Rule Curve operations.

NavSwitch This switch allows the user to select navigation targets either by setting the Nav Trial Depth Switch, or to select navigation targets that are consistent with the Water Control Plan targets. To select the depth control option *NavSwitch* should be set to 1 (this activates the Nav Trial Depth switch) . To select the Water Control Plan targets, *NavSwitch* should be set to 2 (this activates the Water Control Plan navigation targets and disables the Nav Trial Depth option). This switch only works for Rule Curve Operations.

NavDepth When the rule curve operations option is active and the NavSwitch is set to 1, this slider determines the depth of channel that is supported. The user may enter one of the following navigation depths: 0, 7.5, 8.0, 8.5, 9.0. If the user selects a value of zero, no supplemental releases will be made for navigation during the trial. The monthly flowsassociated with these navigation depths were supplied by the USACOE. Units ft.

NavMonthSelect This graphical function icon allows the user to select the months for which navigation support is active. This control option works for both WCP and Rule Curve operations. The user may enter a 1 for each month for which navigation is to be supported, and a zero for each month for which navigation support is to be disabled.

NavTargetMultiplier This variable multiplies the Blountstown target by a fixed factor set by the user. This number can be used to adjust the monthly model to mimic daily navigation support operations or to explore ranges of navigation targets.

NavWinSwitch This switch activates or disables navigation windows operation. The default value of 0 disables navigation windows. Setting the switch to 1 activates navigation windows. Unitless.

NavWinSwitch This graphical function specifies the months for which navigation windows are active.

NavWinDays This graphical function specifies the number of days of navigation support for each month, and 3 triggering options for windows. Navigation MOPs are configured for average windows flows automatically when windows areactive in a given month. The flows for other days of the month are the minimum flows. Units days.

NavWinOption This variable selects when navigation windows are active. Options:

> 0 Active or passive windows. Navigation Windows always active when NavWinSwitch=1
>
> 1 Passive windows only. Navigation Windows active only when *NavWinSwitch*=1 AND Blountstown flow-by is less than flow for 7.5 foot full-time depth. Note that Navigation flows should not be supported with upstream storage while using this option.
>
> 2 Active windows only. Windows are active only when *NavWinSwitch*=1 AND % system storage is less than value set at *NavWin%StorTrigger*. Flow targets should be actively supported while using this option.

NavWin%StorTrigger This slider allows the user to set the percent of full pool storage that triggers active navigation windows (navigation windows option 2). Units %.

BUNavSupSwitch This slider allows the user to eliminate navigation support from Lake Lanier for both WCP and Rule Curve operations.

> Switch=0 --Lanier storage is used to support navigation.
>
> Switch=1 --Lanier storage not used to support navigation.

BUNavFraction This slider allows the user to setthe fraction of shared water from Lake Lanier allowed for use in navigation support during each timestep when the rule curve option is active. Note that this variable will have no effect if the BUNavSupSwitch variable is not set to 0 on the slider above. Setting this switch to a value less than one biases navigation support towards use of West Point and W.F. George Storage.

WPNavSupSwitch This slider allows the user to eliminate navigation support from West Point for both WCP and Rule Curve operations.

> Switch=0 --West Point storage used to support navigation.
>
> Switch=1 -West Point storage not used to support navigation.

WPNavFraction This slider allows the user to set the fraction of shared water from West Point allowed for use in navigation support during each timestep when the rule curve option is active. Note that this variable will have no effect if the WPNavSupSwitch variable is not set to 0 on the slider above. Setting this switch to a value less than one biases navigation support towards use of Lanier and W.F. George Storage.

ChipolaCut cfs This slider allows the user to set the volume of water diverted through Chipola Cutoff. Water is diverted from below the Blountstown gage in the Apalachicola River and returns to the Blountstown to Sumatra Reach via the Chipola River. Flows at Blountstown are therefore notdirectly affected by this icon. Units cfs.

Navigation Targets

Water Contrtol Plan: The graphical function icons *Zone1Nav*, *Zone2Nav* and *Zone3Nav* specify the navigation targets when WCP operations are active or when WCP navigation targets are selected in Rule Curve operations. *Zone1Nav*, *Zone2Nav* and *Zone3Nav* are monthly flow estimated in the WCP for a 9 ft, 8 ft and 7.5 ft channel depth at the Blountstown gage. *Zone1Nav* targets are active when the highest zone at WP and WFG is zone 1. *Zone2Nav* targets are active when the highest zone at WP and WFG is zone 2. *Zone3Nav* targets are active when the highest zone at WP and WFG is zone 3. The flow/depth relationships are based on the latest navigation study estimates. Units are in cfs.

Rule Curve: The graphical function icons *NavFlow 7\5 ft*, *NavFlow 8 ft*, *NavFlow 8\5 ft* and *NavFlow 9 ft* allow the user to modify navigation targets for Rule Curve operations. The default values are the most recent Corps estimates of flows required to achieve the various depths. Note that changing these values also changes the standards for the navigation measures of performance. *NavFlow 7\5 ft, NavFlow 8 ft, NavFlow 8\5 ft* and *NavFlow 9 ft* icons are the monthly flow estimates necessary to achieve a 7.5 ft, 8 ft, 8.5 ft and 9 ft channel respectively at Blountstown. The effects of dredging are included. These icons' units are cfs.

Recreation Controls

The user may set the first recreation impact levels for Lake Lanier, West Point Dam and W.F. George Dam by setting the graphical functions; ***LanRecImpactElev, WPRecImpactElev,*** and ***WFGRecImpactElev*** respectively. These values only affect the recreation MOPs and do not alter reservoir releases. Units are feet.

Groundwater Pumping Effects Controls

The following sliders allow the user to specify the fraction of ground water use in Sub Area Four that affects surface flows ***FracGWReducingSur*** and the coefficients of a generalized lag equation (up to eight terms). The default values approximate the methodology used to produce the unimpaired flows.

The total steady-state reduction in surface flows associated with a constant pumping rate (as a fraction of pumping rate) is the sum of the lag terms used in the generalized equation and is shown in a display box (***TotalSSFraction***) in the Effects of Groundwater sector of the user interface. If the user wishes to change this value the lag equation constants should be scaled up or down so that the sum of the factors is the desired steady-state fraction affecting surface flows. ***TotalSSFraction*** must not exceed 1.0.

ACT Control Options

1. M&I, Agricultural, and Thermal Demand Controls

ConsCurtTrigger *Graphical control*. Specifies decimal fraction of available system free volume (the total amount of water in all of the storage reservoir's conservation pools) to total system free volume (the total full conservation pool volumes) which initiates global demand (all M&I, Ag, and Thermal demands) modification curtailment fraction specified by **Demand Factor**.

DemandFactor   *Graphical control*. Global demand modification curtailment factor; specifies the decimal fraction of projected demands to be imposed on the system. May be used in conjunction with demand specific curtailment factor controls.

M&ICurtFactor *Graphical control*. Demand specific curtailment factor control. Specifies the decimal fraction of projected M&I demands to be imposed on the system.

AgCurtFactor *Graphical control.* Demand specific curtailment factor control. Specifies the decimal fraction of projected Ag demands to be imposed on the system.

ThermCurtFactor *Graphical control.* Demand specific curtailment factor control. Specifies the decimal fraction of projected Thermal demands to be imposed on the system. Slider control in the ACF.

AddXferFromCoosa *Graphical control* used to specify an additional interbasin transfer from the ACT Coosa River to the ACF basin. Withdrawn in Rome Reach 3.   Represented as an uncurtailed demand.

AddXferFromTallapoosa *Graphical control* used to specify an additional interbasin transfer from ACT Tallapoosa River to ACF basin. Withdrawn at Georgia Tallapoosa Reach 10. Represented as an uncurtailed demand.

NOTE: AddXferFromTallapoosa and **AddXferFromCoosa** represent uncurtailed demands. These controls represent additional withdrawals in the ACT, and additional surface water inputs in the ACF. Default values for these parameters are zero, in that their relative contributions have not been explicitly identified in PMCL data sets at this point. As such, their effects are masked in the model. These parameter controls have no bearing on MOP reference conditions.

SumSurfWithXXX (Where XXX is a surrogate for river reach, such as Alla, for Allatoona reach). *Slider control,* one control per reach. Used to specify the magnitude, by reach, of the sum of M&I, Agricultural, and Thermal surface water withdrawals.

SumSurfRetXXX (Where XXX is a surrogate for river reach, such as Alla, for Allatoona reach). *Slider control,* one control per reach. Used to specify the magnitude, by reach, of the sum of M&I, Agricultural, and Thermal surface water returns.

M&I%GWWithXXX *Graphical Controls* which allow user to specify the decimal fraction of M&I demands, for various reaches, to be withdrawn from groundwater.

Ag%GWWithXXX *Graphical Controls* which allow user to specify the decimal fraction of Agricultural demands, for various reaches, to be withdrawn from groundwater.

2. Instream Flow Controls

XXXTarFlowcfs *Graphical controls* which allow user to adjust instream flow targets as a function of month for the following targets: Jordan, Thurlow, Wadley, Montgomery, and Claiborne.

3. Hydropower Controls

PeakHrsSwitch *Slider*. Operational tool allows the user to specify peaking hours by WCP (default), by month (in conjunction with **XXXPeakHrsMO**), or as a function of percent of available free volume (in conjunction with **XXXPeakHrsCAP**).

PeakDaysPerWeek *Slider* Specifies the number of peaking days per week.

AllaZone1PeakHrs *Slider*. Allows the user to specify the number of WCP Zone 1 peaking hours at Allatoona.

AllaZone2PeakHrs *Slider*. Allows the user to specify the number of WCP Zone 2 peaking hours at Allatoona.

AllaPeakLoadHrs *Slider* A user defined parameter in ARC dependable capacity measure of performance estimating method. Does not effect reservoir releases at Allatoona.

CarReqEnergy/HrsSwitch *Slider* Selects whether the energy requirement at Carters is defined by the number of peak hours or by a set energy requirement.

CarPeakLoadHrs *Slider* A user defined parameter in ARC dependable capacity measure of performance estimating method. Does not effect reservoir releases at Carters.

CarPeakHrsDefault *Slider* Allows the user to change the number of default daily peaking hours.

CarMaxPumpHrs *Slider* User defined number of Carter re-regulation dam daily pumpback operations hours.

CarEnrgyRegEnergy *Graphical control.* Allows the user to specify the hydropower energy requirement as a function of month for Carters dam. Active when **CarReqEnergy/HrsSwitch** equals 1.

XXXPeakHrsMO *Graphical control.* Allows the user to specify the number of daily peaking hours as a function of month for Carters, Allatoona, Weiss, HN Henry, Logan Martin, Harris, and Martin dams. Used in conjunction with **PeakHrsSwitch.**

XXXPeakHrsCAP *Graphical control.* Allows the user to specify the number of daily peaking hours as a function of percent of available free volume for Carters, Allatoona, Weiss, HN Henry, Logan Martin, Harris, and Martin dams. Used in conjunction with **PeakHrsSwitch**

4. Max Deficit Algorithm

MaxDeficitSwitch *Slider* allows the user to calculate cumulative storage deficits in storage reservoirs.

MaxDefTrigger% *Slider* specifies trigger volume, based upon percent system available storage, which initiates the maximum deficit algorithm.

5. GA Coosa M&I Adjustment Factors

XXXM&IAdjFactor *Graphical Controls* which allow user to increase or curtail withdrawals and returns for the following reaches in the Georgia Coosa/Tallapoosa basins: Carters, Allatoona, GA Tallapoosa, and Rome. Note that this curtailment is compounded (multiplicative of) when used in conjunction with global curtailment factors; to avoid confusion should not be used with global curtailment factors.

6. Corps Reservoir Controls and Coosa State Line Flow Statistics

CarUse% *Slider* which allows user to specify the percentage of shared water available in (a) meeting a state line flow target on the Coosa and (b) supporting a system navigation target. Effectively shifts responsibility of meeting state line target to Allatoona, however also effects the amount of water available to meet Claiborne system navigation target.

AllaUse% *Slider* which allows user to specify the percentage of shared water available in (a) meeting a state line flow target on the Coosa and (b) supporting a system navigation target.

Effectively shifts responsibility of meeting state line target to Carters, however also effects the amount of water available to meet Claiborne system navigation target.

GAALCoosaTarFlow cfs *Graphical Control* which allows the user to set the Coosa state line flow target as a function of month.

7. West Georgia Reservoir Controls

WestContRelSwitch *Slider*. Allows user to specify one of five continuous reservoir continuous release scenarios.

WestRuleElev *Graphical Control*. Allows the user to modify rule curve elevations. Default rule elevations equal bottom elevations, which forces run-of-river operations. Utilize values in the table below this graphical control icon to establish rule curve elevations above bottom elevations, resulting in storage reservoir operations.

WestBotElev *Graphical Control*. Allows the user to specify the bottom of conservation pool elevation.

WestSeasonalContRel *Graphical Control* Allows the user to specify the continuous release seasonal flow regime. Used in conjunction with **WestContRelSwitch.**

West30%AnnAvgContRel *Slider*. Allows the user to specify the 30% annual average daily low flow continuous release requirement. Used in conjunction with **WestContRelSwitch.**

West7Q10ContRel *Slider*. Allows the user to specify the 7Q10 low flow continuous release requirement. Used in conjunction with **WestContRelSwitch.**

GAALTallaTarFlow cfs *Graphical Control* Used to specify the Tallapoosa state line flow target to be met from the West Georgia reservoir.

8. Conservation Pool Adjustments

XXXEndRuleElev *Graphical control* allows the user to specify end of month rule curve elevation for each storage reservoir.

XXXEndBotElev *Graphical control* allows the user to specify the end of month bottom of conservation pool elevation for each storage reservoir.

AllaZoneElev *Graphical control* allows the user to specify the bottom of Zone 2 at Lake Allatoona.

9. Navigation Controls

NavSwitch *Slider*. The user specifies whether the APCO (Jordan, Bouldin, Thurlow), System (Claiborne), or both navigation targets are to be met.

NavUseCorps *Slider*. Allows the user to specify that the Corps facilities of Carters and Allatoona are used to support the Claiborne flow target in conjunction with the APCO projects. The default is to use Corps projects; setting the slider to zero means that only APCO projects are used to meet navigation targets.

NavMonthSwitch *Graphical control*. Allows the user to turn system navigation support off for specified months.

APCONavTarFlow *Graphical control*. Specifies the combined flow target (Jordan, Bouldin, and Thurlow continuous release requirement) to be met from all APCO reservoirs.

NavWindowsDays *Slider* specifies the number of days for which navigation windows are active during the month.

NavWinMincfs *Slider*. The required flow for the non-window portion of the month at Claiborne. If this flow cannot be supported during the non-windows portion of the month, then navigation windows cannot be employed during the month.

ClaNavDepth *Graphical control*. If System navigation target enabled, specifies the target navigation depth. Employs then the following controls to calculate flow requirement as a function of month, upon which system operates and MOPs are calculated.

NavFlowSwitch *Slider*. Used to specify alternative channel rating curves, developed by Bill Stubblefield, which define the navigational channel targets.

10. Recreation Controls

RecImpactSwitch *Graphical Control* which specifies months for which recreation impacts will be calculated.

XXXRecImpactElev *Graphical Control* which specifies the recreation impact elevation, for each storage reservoir, below which recreation impacts will be calculated.

ACF Measures of Performance (MOP's)

Demand Withdrawal MOPs

Entire Run: The Reliability and Vulnerability of meeting M&I, Thermal and Agricultural demand withdrawals for the entire run are reported**.** Reliability is in units of % and vulnerability is in units of mgd.

Drought Period: The reliability and vulnerability of meeting M&I, Thermal and Agricultural demand withdrawals for the period from Jan 1985 to Dec. 1989. Note that the run must include the entire period from Jan 1985 to Dec. 1989 to produce consistent results. Reliability is in units of % and vulnerability is in units of mgd.

2. Instream Flow MOPs

The reliability, vulnerability and number of failures (shortfall count) of meeting minimum flows, which may be set by the user, for Peachtree Creek, Columbus and Blountstown. Reliability (%). Vulnerability (cfs).

3. Hydropower MOPs

XXXEngShortCount represents the number of times specified peak and non-peak generating hours are not met during the run.

XXXEngReliability represents the reliability, in percent, of meeting specified peak and non-peak generating requirements.

XXXEngVulnerabilty represents the average vulnerability, in MWhrs, of failure in meeting specified peak and off-peak requirements, assuming full pool head.

SEPAShortCount represents the number of times the system fails to meet 22% of SEPA energy contract requirements.

SEPAReliability represents the reliability, in percent, of the system meeting 22% of SEPA energy contract requirements.

SEPAVulnerabilty represents the average vulnerability, in MWhrs, of failure in meeting 22% of SEPA energy contract requirements.

XXXEngReliability 2 represents the reliability, in percent, of meeting specified firm energy requirements.

XXXEngVulnerabilty 2 represents the average vulnerability, in MWhrs, of failure in meeting specified firm energy requirements. Units MWHR/month.

XXXMinFirmEnergy minimum firm energy for the period run, units MWHR/day.

XXXDepCap estimated dependable capacity in MW.

XXXAvgFirmEng average firm energy in MWhr/month.

AvgXXXNonFirm average non-firm energy in MWhr/month.

MinSEPAPeakEng, MinGPPeakEng minimum peak energy generated during the run for SEPA and Georgia Power plants respectively. Units MWhr/month.

AvgSEPAPeak, AvgGPPeakEng average peak energy generated during the run for SEPA and Georgia Power plants respectively. Units MWhr/month.

AvgSEPAOffPeak, AvgGPOffPeak average off-peak energy generated during the run for SEPA and Georgia Power plants respectively. Units MWHR/month.

4. Maximum Deficit MOPs

MaxDefTotal The number of timesteps that deficits occur in minimum reservoir volume, system volume and in either (total deficit) are reported. Deficit may occur as a result of one (or both) of two triggers being activated. One trigger is activated when any reservoir reaches the bottom of conservation pool (minimum reservoir volume) while the other is triggered when total volume of water available in the system reaches a limit set by the user ***(MaxDefTrigger%).*** This measure gives the number of times each trigger is activated and the total number of times any trigger is activated.

Sys%Total tracks the number of times that the Max Deficit algorithm is triggered by MaxDefTrigger%.

Min%Total tracks the number of times that conservation storage in any of the is depleted. Will trigger Max Deficit algorithm if MaxDeficitSwitch is enabled.

XXXORMaxDet_cfsd reports the minimum additional amount of water necessary at each storage facility to meet out of reservoir requirements. Units cfsd.

XXXRecMaxDef_*cfsd* reports the minimum additional amount of water necessary to maintain recreation pool levels. Units cfsd.

XXXTotalMaxDef reports the sum of ***XXXORMaxDef_***cfsd and ***XXXRecMaxDef_****cfsd.*

5. Navigation MOPs

FTNavCount7/5,8,8/5,9 reports the number of shortfalls incurred in meeting fixed full-month 7.5, 8, 8.5, and 9 foot navigation channels.

FTNavRel7/5,8,8/5,9 reports the reliability, in percent, in meeting fixed full-month 7.5, 8, 8.5, and 9 foot navigation channels.

FTNavVuln7/5,8,8/5,9 reports the average vulnerability, in cfs, in meeting fixed full-month 7.5, 8, 8.5, and 9 foot navigation channels.

NavWinCount7/5,8,8/5,9 Number of navigation shortfalls at Blountstown for the run. These MOPs are based on average navigation windows flows required. Unitless.

NavWinRel7/5,8,8/5,9 Reliability of navigation flows at Blountstown. These MOPs are based on average navigation windows flows required. Units %.

NavWinVuln7/5,8,8/5,9 Vulnerability of navigation flows as measured by the average shortfall during shortfall events. These MOPs are based on average navigation windows flows required. Units cfs.

NavShortCount7/5,8,8/5,9 Number of navigation shortfalls at Blountstown for the run. These MOPs are based on full-time 7.5 foot channel flow requirements unless navigation windows have been activated, in which case the MOPs track average flows required for navigation windows. Unitless.

NavReliability7/5,8,8/5,9 Reliability of navigation flows at Blountstown. These MOPs are based on full-time 7.5 foot channel flow requirements unless navigation windows have been activated, in which case the MOPs track average flows required for navigation windows. Units %.

NavVulnerabilty7/5,8,8/5,9 Vulnerability of navigation flows as measured by the average shortfall during shortfall events. These MOPs are based on full-time 7.5 foot channel flow requirements unless navigation windows have been activated, in which case the MOPs track average flows required for navigation windows. Units cfs.

NavShortCount reports the number of times specified navigation channels are not met.
NavReliability reports the reliability of specified navigation channels. Units percent.

NavVulnerabilty reports the average vulnerability, in cfs, of specified navigation channel shortfalls.

6. Recreation MOPs

Number of failures, reliability, vulnerability of lake elevations above the drawdown limit. Reliability (%). Vulnerability is in feet below first recreation impact level (which may be set by the user).

Number of failures, reliability and vulnerability of flows at Blountstown corresponding to a 5 ft stage. Reliability (%). Vulnerability is in feet below 5 ft stage.

Minimum Lake Elevations

Blountstown Flow Statistics; Flow statistics for Blountstown measuring point. Last data point of run is excluded from the statistics due to the calculation algorithm. Units cfs.

Minimum flow, maximum flow, variance in flow and average flow at the Blountstown point are reported for the entire run. These values are also reported for each month (January, February, etc.) for the run.
ACT Measures of Performance

1. M&I, Agricultural, and Thermal Demand MOPs

Number of Shortfalls reports the number of times demand requirements were not met for the period of record run, by reach.
Reliability % Calculated by subtracting the number of shortfalls divided by the number of timesteps run from one, then multiplying by 100. By reach.
Vulnerability mgd Calculated by dividing the total shortfall amount during the entire run by the number of times a shortfall occurred. By reach.

2. Instream Flow MOPs

The following MOPs are offered for the following flow targets: Jordan, Thurlow, Wadley, Montgomery, and Claiborne. Only the Jordan and Thurlow targets are licensed to be met at present.

Number of Shortfalls reports the number of times demand requirements were not met for the period of record run, by reach.

Reliability % Calculated by subtracting the number of shortfalls divided by the number of timesteps run from one, then multiplying by 100. By reach.

Vulnerability cfs Calculated by dividing the run sum of shortfalls by the run sum number of shortfalls. By reach.

3. Hydropower MOPs

The following MOPs are offered for Carters and Allatoona:

XXXDepCap dependable capacity, based on George McMahon's method, in Mwhrs.

XXXMinFirmEnergy Minimum firm energy production for the run. Units Mwhr.

XXXAvgNonFirm Average non-firm energy for the run. Units Mwhr/month.

XXXEngReliability Average energy production reliability. Units percent.

XXXEngVulnerability Vulnerability of firm energy production at Carters Dam as measured by the average energy shortfall during shortfall events. Units Mwhr/month.

XXXMaxHrsGen The lowest number of hours per week day that peaking releases may be made. This value is a surrogate for dependable capacity.

The following MOPs are offered for Carters, Allatoona, Weiss, HN Henry, Logan Martin, Harris, and Martin reservoirs:

XXXAvgHrsGen The average hours of generation per weekday.

XXXMinHoursGen (**XXX** is used here and throughout as a surrogate for reach specific identification). The maximum number of peaking hours that can be supported during the run. Calculated by determining the minimum number of hours that are available during the run.

4. Maximum Deficit Algorithm MOPs

MaxDefAlgTotal reports the number of times that the Maximum Deficit Algorithm is initiated during the model run.

Sys%CapTotal The number of times the maximum deficit algorithm is activated by user specified **MaxDeficitTrigger%** percentage.

Min%CapTotal The number of times the maximum deficit algorithm is activated because one of the reservoirs runs completely out of water.

XXXORMaxDeficit reports the maximum cumulative out of reservoir demand shortfalls in cfs-days for each storage facility.

XXXRecMaxDeficit reports the maximum cumulative recreation demand shortfall in cfs-days for each storage facility.

XXXTotMaxDeficit reports the sum of XXXORMaxDeficit and XXXRecMaxDeficit.

5. GA Coosa M&I Adjustment Factors

See M&I, Agricultural, and Thermal Demand MOPs

6. Corps Reservoir Controls and Coosa State Line Flow Statistics

GACoosaSupTotal The total volume of water from the GA Coosa that is provided by supplemental releases over the entire run. Includes navigation and state-line flow target. Units cfs-days.

GAALCoosaTarShortCount The number of shortfalls in meeting the Coosa state line flow target.

GAALCoosaTarReliability Reliability, in percent, of meeting the Coosa state line flow target.

GAALCoosaTarVulner Average vulnerability, in cfs, of Coosa state line target shortfall events.

CoosaMax Maximum monthly average Coosa flow rate across state line. Units cfs.

CoosaMin Minimum monthly average Coosa flow rate across state line. Units cfs.

CoosaAverage Average monthly Coosa flow rate across state line. Units cfs.

CoosaVariance Statistical variance of monthly average Coosa flow rate across state line. Units cfs.

7. West Georgia Reservoir MOPs

GAALTallaTarShortCount The number of shortfalls in meeting the Tallapoosa state line flow target.

GAALTallaTarReliability Reliability, in percent, of meeting the Tallapoosa state line flow target.

GAALTallaTarVulner Average vulnerability, in cfs, of Tallapoosa state line target shortfall events.

TallaMax Maximum monthly average Tallapoosa flow rate across state line. Units cfs.

TallaMin Minimum monthly average Tallapoosa flow rate across state line. Units cfs.

TallaAverage Average monthly Tallapoosa flow rate across state line. Units cfs.

TallaVariance Statistical variance of monthly average Tallapoosa flow rate across state line. Units cfs.

GATallaSupTotal The total volume of water from the GA Tallapoosa that is provided by supplemental releases over the entire run. Includes navigation and state-line flow target. Units cfs-days.

The following are flow statistics for the Little Tallapoosa river:

LitTallaMax Maximum monthly average Little Tallapoosa flow rate across state line. Units cfs.

LitTallaMin Minimum monthly average Little Tallapoosa flow rate across state line. Units cfs.

LitTallaAverage Average monthly Little Tallapoosa flow rate across state line. Units cfs.

LitTallaVariance Statistical variance of monthly average Little Tallapoosa flow rate across state line. Units cfs.

8. Conservation Pool MOPs

There are currently no conservation pool MOPs.

9. Navigation MOPs

ApCoNavShort Count reports the number of shortfalls at the combined Jordan, Bouldin, and Thurlow 4640 navigation cfs target.

ApCoNavReliability reports reliability, in percent, of meeting the combined Jordan, Bouldin, and Thurlow 4640 cfs target.

ApCoNavVulnerability reports the average, in cfs, of shortfalls at the combined Jordan, Bouldin, and Thurlow 4640 cfs navigation target.

NavWin0 Given a shortfall, reports the number of times that navigation windows would not meet the respective targets if employed.

NavWin7.5, 8, 8.5, 9 Given a shortfall, reports the number of times that navigation windows would meet the respective targets if employed.

SysNavShortCount reports the number of shortfalls at the Claiborne navigation target for depth defined by the user.

SysNavReliability reports reliability, in percent, of meeting the Claiborne target for depth defined by the user.

SysNavVulnerability reports the average, in cfs, of navigation shortfalls at the Claiborne target for depth defined by the user.

Nav7.5, 8, 8.5,9 ShortCount reports the number of navigation shortfalls at the Claiborne (system) target.

Nav7.5, 8, 8.5,9 Reliability reports reliability, in percent, of meeting the Claiborne target.

Nav7.5, 8, 8.5,9 Vulnerability reports the average, in cfs, of navigation shortfalls at the Claiborne target.

10. Recreation MOPs

XXXRecShortCount Number of times reservoir levels fall below user specified recreation impact levels.

XXXRecReliability in percent.

XXXRecVulnerability reports the average shortfall in feet below specified recreation impact level.

Table 34. Information Sources for the Operating Rules in the Shared Vision Model

Apalachicola-Chattahoochee-Flint River Basin Reservoir Regulation Manual (date unknown)
ACF River Basin Reservoir Regulation Manual (Post-1985 Water Control Plan)
Post Authorization Change Notification Report for the Reallocation of Storage From Hydropower to Water Supply at Lake Lanier, Georgia (1985?). (PAC Report)
Reservoir Operations Manuals (An individual manual for each project prepared by the Corps)
HEC-5 model for the ACF (7/94)
ACT River Basin Reservoir Regulation Manual (RRM), Water Control Manual (WCM)
Albama Power Company Reservoir Management (RM) (Note: There are no reservoir operations manuals for the Alabama Power run-of-river reservoirs.)
ACT River Basin Reservoir Regulation Manual (Post-1985 Water Control Plan) Reservoir Operations Manuals (An individual manual for each project prepared by the Corps)
HEC-5 model for the ACT (7/94)
ACTDATA.XLS (Excel file showing all model parameters in tabular form.
FERC license for Project No. 2407; 2/3/94
Order on Rehearing for FERC Project No. 618-023; 7/31/91